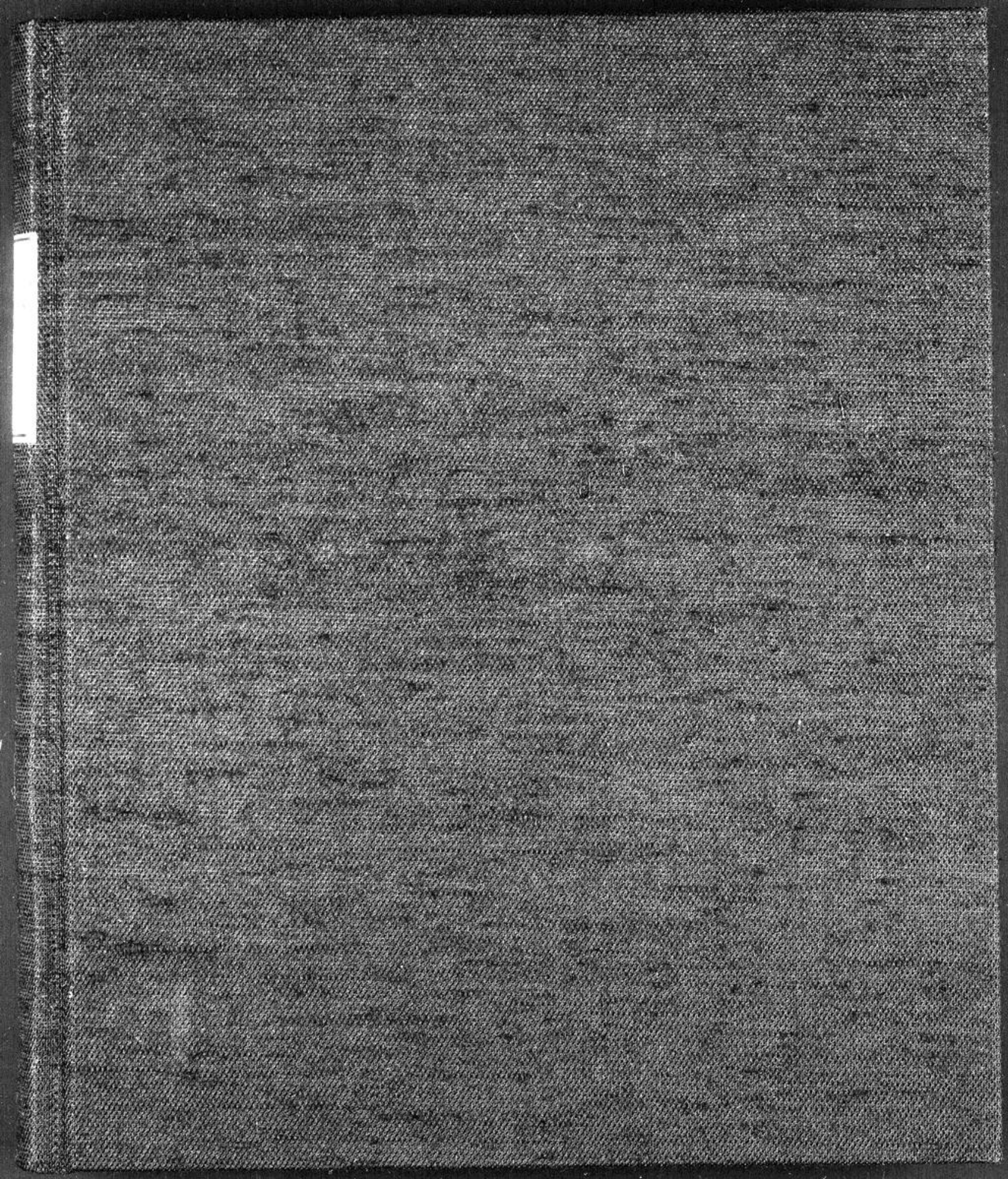


Experimental Note Book
Vol. IV

Thoughts upon Various Subjects

by

Alexander Graham Bell

Boston. U.S.A.
1877

August 30th 1877. Some queries in the London Papers concerning the effects of the late Eclipse of the Moon upon the weather have recalled to my mind by-gone thoughts concerning lunar attraction. It is a curious fact that farmers and sailors in all parts of the world have a deep-rooted conviction that the moon plays some important part in influencing the weather — and meteorologists — while upsetting by hard statistics the theory of a change of weather all over the world at the periods of full-moon and new moon — still grant to our satellite some slight unknown disturbing influence upon the atmosphere.

It has struck me that perhaps an enquiry into the effects produced upon a fluid body by the attraction of a solid — may give a clue as to the real effects of lunar attraction upon the atmosphere...

I shall therefore attempt to determine the effects (qualitative) of a solid M (Fig I) when caused to pass over the fluid A as shown by the arrowhead in the diagram. Should the enquiry

N.B. In the case shown in Fig I. we have two opposing forces acting upon the liquid. The earth's attraction pulling the liquid downwards and M pulling it upwards

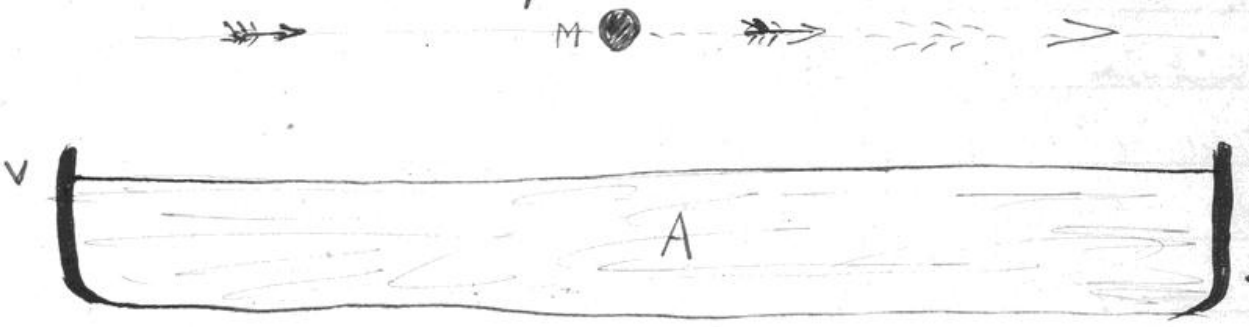
~~The liquid if free to move can move only in the direction of the greater force~~

A body under the influence of opposing forces ~~if free to move~~ will tend to move only in the direction of the greater force. ~~It is therefore evident that the~~ So long then as the attractive effect of M upon the liquid A is less than that of the earth — it will be impossible for M to ~~lift~~ move one particle of the fluid under it — it can only alter its weight.

N.B. Title of Paper. "On the inefficiency untrustworthiness of the mercurial barometer as an index of pressure."

seem to be leading to important results — it will be easy to make the examination quantitative instead of qualitative and thus determine whether the disturbing influence of the moon upon the atmosphere is of sufficient magnitude to be taken account of by meteorologists or not.

Fig I



Let the fluid A be placed in a vessel VV whose bottom is perfectly horizontal; then the fluid will be of uniform depth ~~all over~~ ~~point of the bottom~~ ~~and exert a uniform pressure~~ and will exert the same pressure upon every point of the bottom. The problems to be solved are:

1st What will be the effect of the presence of an attractive body M upon the fluid A; and

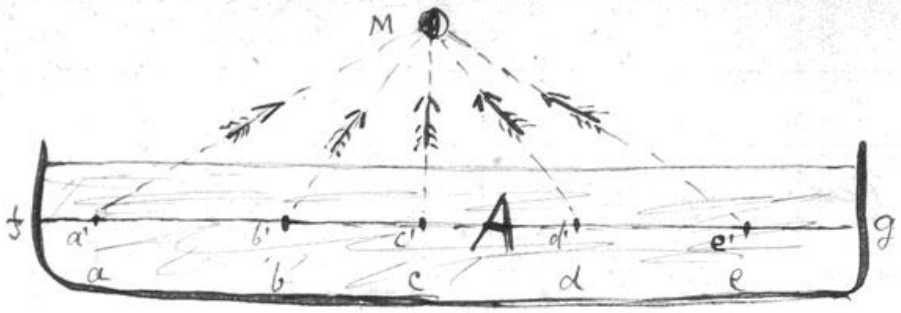
2d What effect will be produced by the motion of the body M in the direction shown by the arrowhead.

(1) The columns of liquid open a b c d x e will therefore be pulled towards M in the directions shown by the arrowheads.

The liquid A is thus under two opposing forces the attractive power of the earth and of the body M.

The body M by opposing the attraction of the earth must affect the weight of the liquid A. At c' the attraction of M is directly opposed to that of the earth but at every other point (a' b' d' e') the attraction of M acts at an angle to that of the earth. In order to determine the change of effect of M's attraction in altering the weights of the columns a' b' d' e' (using the letters denoting their centres of gravity for the columns themselves) it will be necessary to determine the upward effect of M's attraction at the points a' b' d' x e'. This can be done by constructing a triangle of forces, so as to resolve the forces acting at a' b' c' d' into their horizontal & vertical components.

Fig 2.



1st Case. Let the attractive body M be placed as in Fig 2. The fluid A will be attracted upwards towards M but in different degrees at different points. Let us consider the effects upon the columns of liquid over the points a, b, c, d, & e. The centres of gravity of these columns are supposed to lie in the line fg so that the attractive influence of M may be considered ~~upon the~~ merely upon the points a' b' c' d' & e'. (1)

~~Also let the distance of M from the fluid be so great that there shall be no perceptible difference between the lengths of~~ Also let M be ~~so far away from A that it (M) may~~

Fig 3

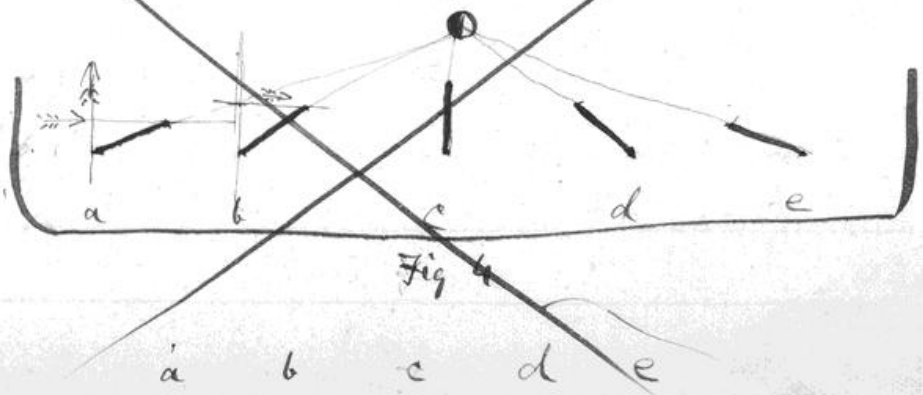


Fig 4

(1) Considering only the vertical components of M's attraction at each point we obtain the vertical lines shown in Fig 4 as a comparative measure of the upward effect produced by M's attraction at the points a' b' c' d' e'.

The weights of the columns a' b' c' d' e' (Fig 4) will be diminished in different proportions by M's attraction. The column c' which is directly under M will have its weight most diminished and the other columns a' b' d' e' will be less & less affected according as they are further & further away from c'

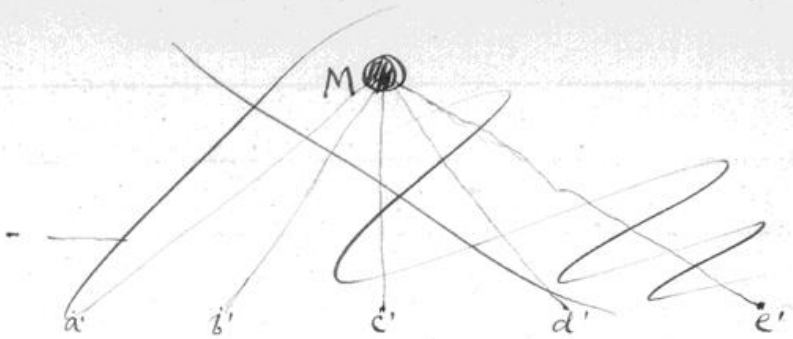
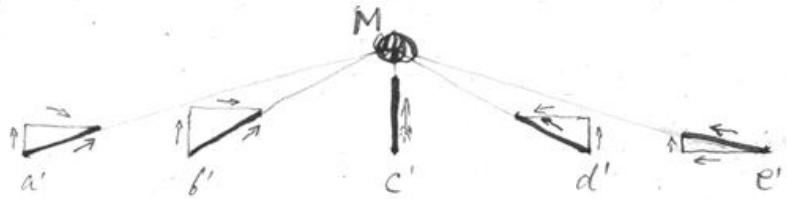


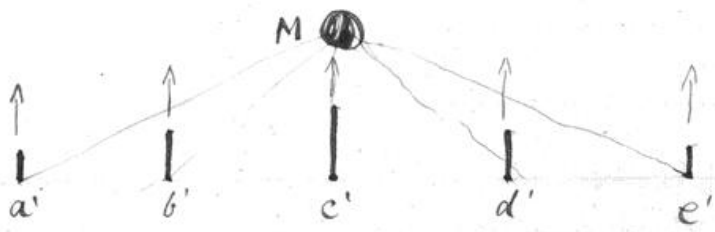
Fig 3.



The heavy line is taken as the measure of M's attraction. Its length (which is uniform at a' b' c' d' & e') indicates the amount of M's attraction, at these points and its direction the direction in which M's attraction acts.

At a' b' d' & e' the forces represented by the hypothenuses of the triangle there figured may be considered as the resultant of two forces (one horizontal & the other vertical represented in magnitude & direction by the light lines of the triangle that is by the sides containing the right angle) — which forces may be considered as acting simultaneously upon the points a' b' d' or e' as the case may be. ①

Fig 4

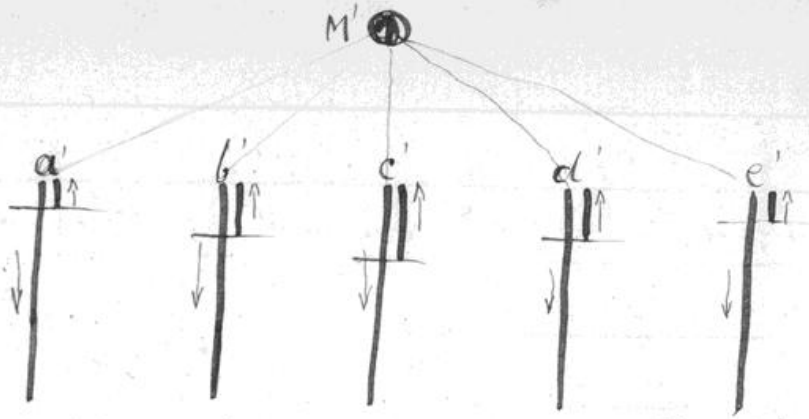


(1) So long as we suppose the attraction of M to be less than that of the earth — it will be impossible for M to move one particle of the fluid A — it can only alter its weight. The resultant of the opposing attractions at each point will still be a downward force acting as shown in Fig 6. The vertical lines at each point a b c d e indicate comparatively the changed weights of the columns over these points.

The pressure of the liquid upon the bottom will be least at the point C under M and will increase gradually at each successive point further removed from C.

Hence while the heights of the columns of liquid remain unchanged by the attraction of M their weights are materially altered. Before considering the motions of the fluid that must result from this disturbance of equilibrium it will be well to consider what effects could be noticed by observers immersed in the liquid at the points a b c d e &c.

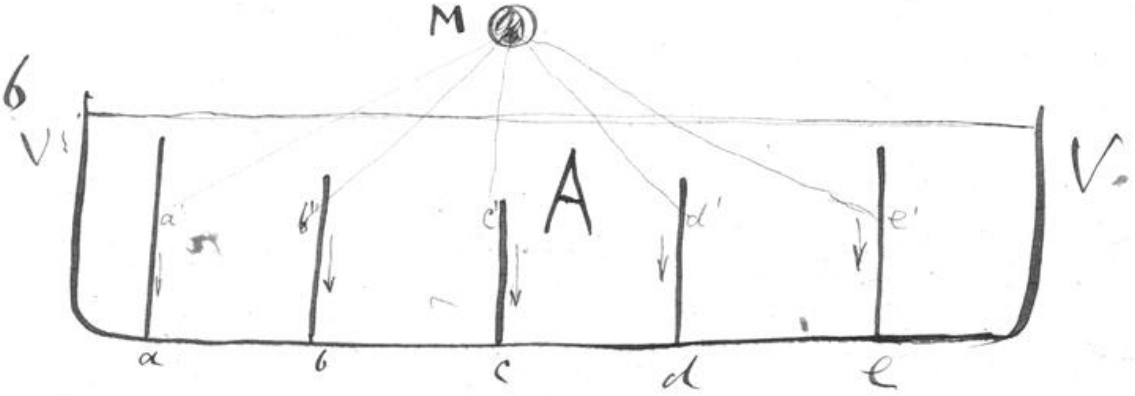
Fig 5



In Fig 5 the ~~two~~ opposing forces at each point are graphically shown ~~at each point~~. The long line indicates the downward attraction of the earth ~~that~~ or is the original weight of each column, and the small line indicates the upward pull due to M's attraction.

By subtracting the latter from the former we have the resultant weights of the columns a'b'c'd'e' as shown in Fig 6. (1)

Fig 6



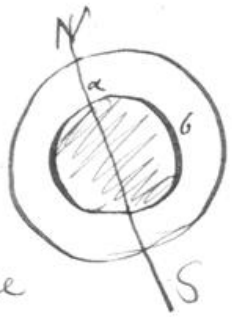
Let observers be stationed at the points a b c d & e provided with mercurial barometers to note the pressure of the fluid at ~~the place of observation~~ the bottom of the vessel VV.

~~Upon~~ ~~the mercury is found to stand at the same height in each barometer~~

N.B. Calculate what effect should be observed by Barometers at Equator & Poles due to rotation of earth & generation of centrifugal force.

Let earth be stationary.

Pressure at a = Pressure at b.



Rotate earth.

Pressure at b becomes less than that at a on account of centrif. force.

Let A = original weight of atmosphere

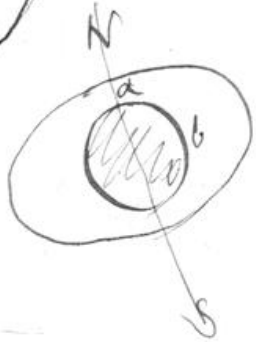
Let B = Centrifugal force

Then Pressure at a = A } when earth is still
and " at b = A }

Pressure at a = A } when earth turns
" " b = A - B }

(Barometer would not indicate difference.)

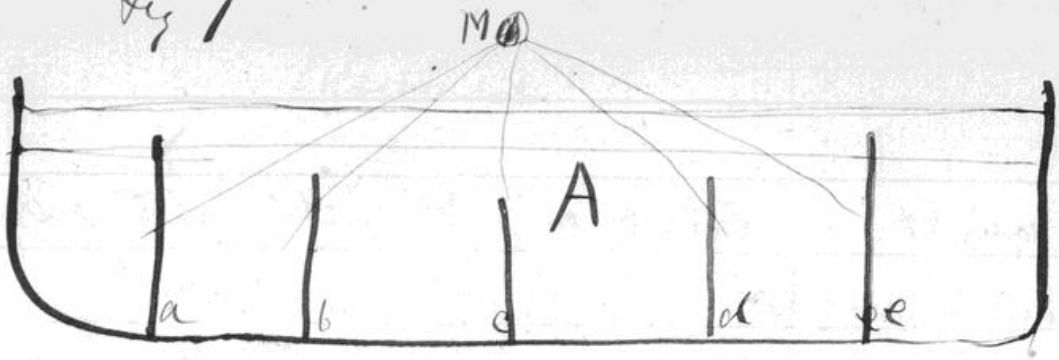
Now the pressure at b being less than at a when earth rotates — the air from the poles pushes the equatorial air up until equilibrium of pressure results as ⇒



Barometer at a would fall and that at b rise.

Hence when centrifugal force comes in the barometers at a & b indicate equality of pressure when there is a difference — and a difference of pressure when there is equality.

Fig 7

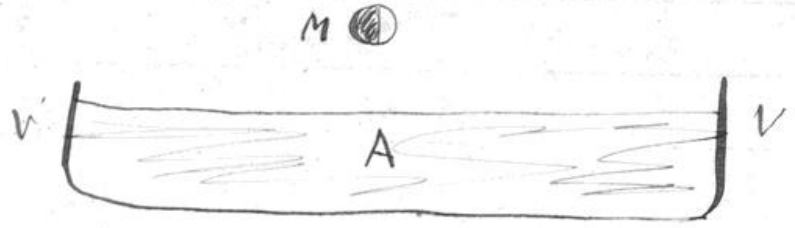


The observers take the height of the mercurial column before M makes its appearance, and find the column of the same height at a b c d and e and hence conclude that the pressures upon the bottom are the same at all the points. Now let M make its appearance. What change will be noticed in the height of the mercury at each station? None whatever. Each observer will find the barometrical level undisturbed — for the attraction of M will lessen the weight of the mercurial column in exactly the same proportion. But the column of liquid is as the weight that The pressure of the fluid is diminished. Hence when M makes its appearance — the barometrical column will be at the same height at all the stations although the pressures upon the bottom are very different.

h. 13 "Free weight" "Latent weight" "Absolute weight"
"Apparent weight" "Effective weight"

Resumée

Fig 8



Effect of presence of attractive body M upon a fluid A

1. Changes weight of liquid
2. Column of liquid immediately under M weighs less than other columns. Weight of columns progressively greater as they are further away from central column.
3. Pressure upon the bottom unequal at different points – but mercurial barometer indicates equality of pressure all over the bottom.
4. Surface of liquid ~~horizontal~~ not changed by M
5. No particle of fluid moved upwards by attraction of M.

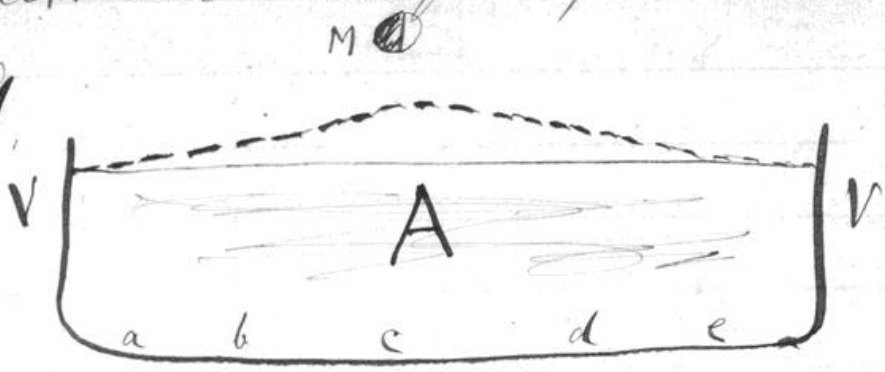
N.B. The ~~first~~ first effect of M is to disturb the equilibrium of the fluid A by taking off a portion of the weight of the ~~columns~~ fluid under M. The surrounding columns - being heavier - push up the liquid under M in the form of a bulge or wave.

The liquid in the wave is not pulled up by the attraction of M as ~~has~~ generally taken for granted — but is pushed up by the surrounding fluid. ~~When the bulge has reached its highest point a certain size~~ The wave rises until the equilibrium of pressure upon the bottom is restored, when all motion ceases. Under these circumstances the columns of liquid over a b c d & e are of equal weight although unequal in height.

(Continuation)

Effects due to unequal pressure on the bottom.

Fig 9



The effect of M upon the liquid A has been shown to consist in a disturbance of the ~~equality~~ of pressure upon the bottom of the vessel V V. But a liquid cannot remain in equilibrium so long as there is a difference in weight ~~of pressure exists at the bottom~~ between contiguous columns. Under such circumstances the heavier columns ~~of~~ buoy up the lighter until the equilibrium of pressure is restored. Hence in Fig 9 ~~the central columns are pushed up~~ the columns of fluid under M are pushed up by the denser columns surrounding them — until ~~the~~ equilibrium of pressure results at the bottom — ~~and the surface being~~ ~~The~~ ~~but~~ in order ~~that this~~ ~~equilibrium~~

When equilibrium results the central columns under M are longer than the surrounding columns ~~but~~ ~~they are~~ although of the same weight — ~~the~~ ~~legs~~ and hence the surface is no longer horizontal but assumes the appearance shown by the dotted line in Fig 9.

Sept. 3d 1877

While in ~~Bath~~ Exeter visited the Deaf & Dumb Institution under supervision of Mr. Hobbah. Not particularly impressed with Institution. Books employed prepared by late principal Mr. Scott

There are 46 pupils — and 3 teachers, (Mr. Hobbah and 2 assistants). Mr. Hobbah is Matron.

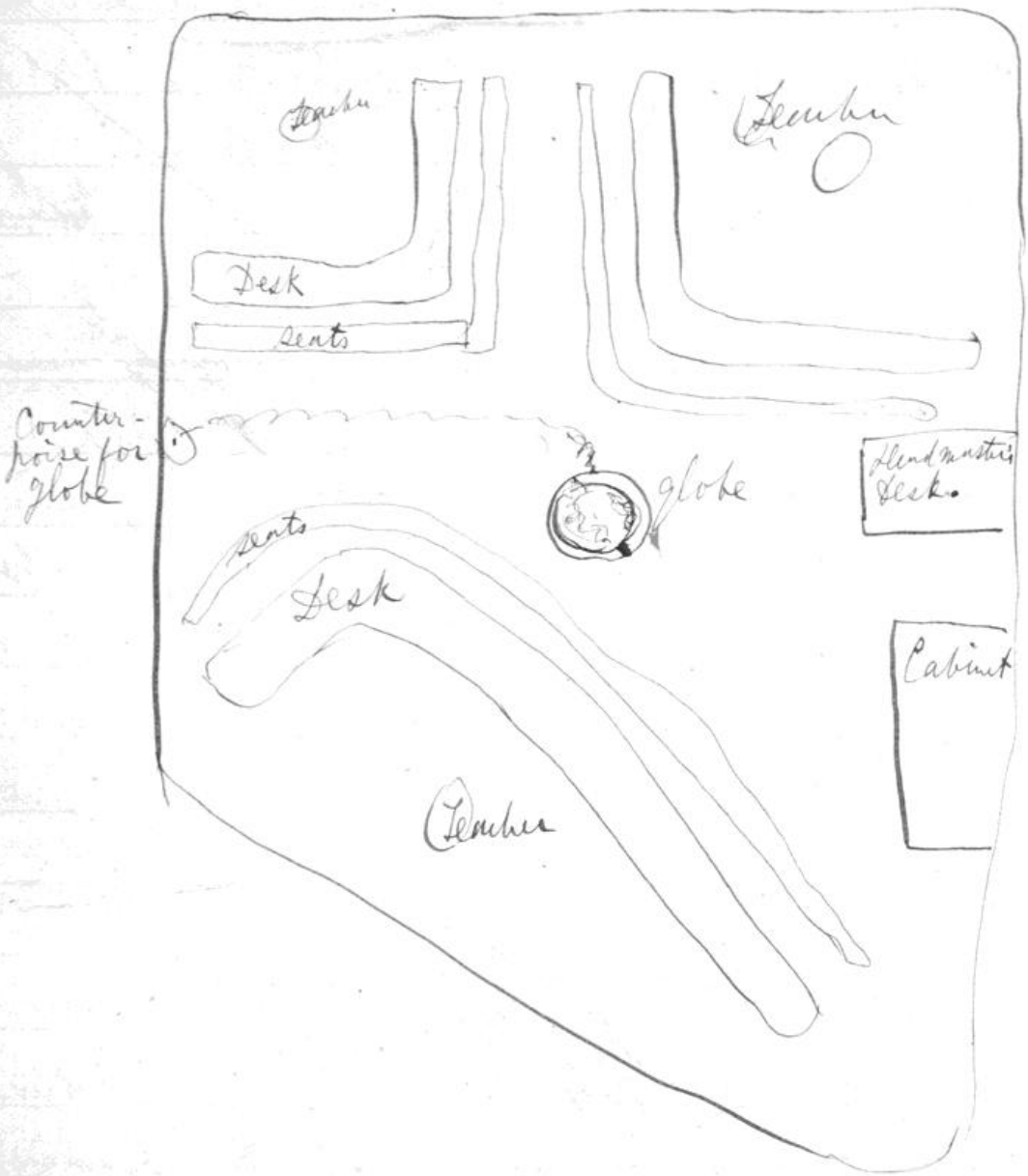
All the classes in the same room. ~~Mr. [illegible]~~ Mr. Hobbah beginning artic. teaching by imitation with some of the semi-mutes. ~~Today lesson~~

Slates round room. Write with pipe-clay instead of chalk. This is a good point as there is no dust. Books shown me by Mr. Hobbah

1. "A graduated course of Language Lessons for the Deaf & Dumb" by James Cook — Edinburgh 1850.
2. "The Deaf & Dumb — Their Education & Social position" by W. R. Scott. — London Bell & Daldy York St. Cov. Gard. 1870

Visited Blind Institution in Exeter also. The school is more industrial than educational. Pupils are taught basket-making, mat-making and fancy-work and brushes. Pupils are taught to read by Lucas' method — and a few of the more difficult cases are taught by Moons. They write by pricking the

A. School-room of Bristol R. & Exam. Institute



characters upon paper by means of movable wooden types having wires arranged on the face (like the bristles of a brush) so as to form the letters as in the figure.

Sept. 3d Bristol.

Deaf & Dumb Inst. Headmaster Wm. W. Barnes Smith
37 pupils. Fourteenth. Mr. Smith evidently a man of great ability and intelligence. Sign language employed here in Easter — but manual alphabet used as much as possible. Nothing done in articulation. Just beginning artic. with one or two semi-mutes and one semi-deaf. Hearing-tube used with semi-deaf. All classes in one room. Arrangement of desks in room worth noticing. (See A.) I have not noticed this feature before of having desks arranged as in diagram so that all the pupils of each master face their proper master while sitting. Slates all round room. Chalk used.

X' Two female teachers employed. In Exeter all are deaf. The male assistant is deaf. Rather think one of the female assistants deaf also. ~~Text books~~

Text books & charts shown to me by Mr Smith differ from those in Exeter.

3. First Lessons or Picture Charts
(Charts with a picture & descriptive story or explanation)
pub. by Just & for D. & D. Newcastle on Tyne

4. Picture Teaching by Janet Byrne (nom de plume for Miss Bessemeres)

5. 200 class Reading Lessons by Charles Baker
Newcastle Just. for D. & D.

6. Book of Bible Events by Baker
London, Darty & Owen, 31 Strand.

7. Picture Lessons by M. Valade Gabel
translated by Charles Baker

8. Scripture Questions (Gradation 2)
by Rev. John Kingham, Ulster Just. Belfast

Over

~~Below~~ Above slate - pictures. Room seems filled with pictures - Biblical - Historical & general. In centre of room is a huge globe not upon stand but suspended from roof by a chain which passes along roof & side wall where a weight counterpoises the globe. The globe can be lowered when used. Pupils gain better idea of earth floating in space from such an arrangement - than when placed on stand. What I consider most noteworthy feature is the Cabinet or Museum - which contains not a collection of curiosities - but of common things - such as tea - coffee - wheat, sand bran, peas, beans, shot powder, biscuits in fact everything not of a perishable nature that can be put together. These are placed in small boxes which are labelled outside.

No trouble in explaining meaning of common terms such as "bran" - show them the thing itself.

Object cards are used also in this school exemplifying common manufactures &c. Pictures made extensive use of in teaching ~~&c~~

(Text-books continued)

9. (Biblical charts) "Preceptive Illustrations of the Bible" Ed. Stanford 6 & 7 Charing Cross.

10. (Charts) Natural History Charts
77 Great Queen St - Lincolns Inn Fields

11. Object Lesson Cards,
Edinburgh Oliver & Boyd - Tweeddale Court
London Simpkin Marshall & Co

12 "First Book of Exercises in English Composition for the Deaf & Dumb" by C. W. R. Scott -
pub. T. Thompson, High St - Exeter -

13. Epitome of Scripture History by William Hutchinson
Edinb. Henderson Bros.

14. Synonyms exemplified by Robert J. Jackson
London Simpkin Marshall -

W. Smith kindly presented me with a copy of Synonyms exemplified

Sept. 3. Bristol Educational Establishments.

Mr. Mark Whitwill — (one of the Bristol School Board — and known here as "The Children's friend") took me with him this afternoon to visit a few Educational Establishments & Charities.

1. "The Crèche" or Infant's Home. Full name of crèche "Elisabeth Proctor Crèche" at Broad Plain — Bristol. Mr. Whitwill real founder of School — though Miss Proctor gave money & started it. This is a most interesting place. Mothers who are engaged in work can leave their infants here during the day. They are brought here in early morning & are fed and cared for till evening for a charge of 2 pence. Children admitted up to five years of age — but majority were infants. Nurses in attendance kind looking. Carry babies about tenderly.

X 3. "Public Elementary School" Bristol

Barton Hill Board School

Elementary school under the Board of Education. Each child pays 2d a week. Admitted about 7 and continues till 13 years of age.

About 250 boys & same number of girls of Elementary rights. In the youngest class boys & girls together under female teacher — after wards — boys & girls separate parts of building. Boys under men — girls under women. 6 grades of classes. Ordinary elementary subjects. Girls have in addition instruction in sewing, domestic economy including practical instruction in cooking. Once a week they have a cooking class & the food cooked is sent to the Day Industrial Feeding School.

Teachers

Salaries

Male

Headmaster £90 and half gov. grant & amounting to about £140 or £50.

Assistant Masters £50

Pupil Teachers £12 & a rise of £2 for 5 years

Some apprenticed for 5 years.

Female

Headmistress £50 and half gov. grant & about £40

Assist. Teachers £30 to £35

Pupil Teachers £10 or 12 with rise of £2

Over

2. "Day Industrial Feeding School" Bristol
Established by Miss Carpenter. A Tablet on the mantel of ~~the~~ the School room in the memory of the founder of the System both here & in America — "J. Tuckerman of Boston U.S."
~~Industrial~~ No fees charged to pupils. Is in fact a ragged school. Little children picked off the streets — whose parents are too poor to pay the slight tuition fees of the public schools are here taught & fed — and clothed — free.
They go early in morning — & have breakfast — Here are looked after — till evening — when they are sent home. Wretched — miserable looking children — though a few bright faces are among them. The only industrial occupations as yet taught are — Wood-chopping to boys — and needle-work to girls — though shoe-making & tailoring is intended to be added soon. Children are here of all ages from five years to about 11 or 12.
Supported entirely by voluntary subscriptions.
It is to be taken under supervision of school-board very shortly.

6. Certified Industrial School for Girls (Bristol)
7. Certified Industrial School for Boys.

These schools are intended for neglected children. Children educated, fed & clothed free to their parents — but — if I remember rightly at the expense of the Board of Education.

Children with drunken parents who neglect them & ill-treat them — Children of thieves — or children frequenting the company of reputed thieves or bad characters — habitual truants — waifs — &c &c — are taken before the magistrates & sentenced to these schools. Children too convicted of misdemeanours & theft sent here.

Their pictures are taken on entrance and miserable looking objects they are on entrance. Ragged — dirty — or rather filthy. Matron (Miss Bell) said sometimes it took a fortnight of daily warm baths to get skin clean. Children have cold bath every morning. ~~Clean~~ Children seem pleasant & clean. Much better dressed & more prepossessing in every way than the child. of the Elem. School.

Over

4. Red-maids School (Bristol) An old endowed School. 80 girls fed clothed, & well-educated free for about 5 years. ~~Five~~ six 5/8th of girls admitted are orphans voted for by Directors &c. The rest are elected by examination from the Elementary School. This acts as a strong inducement to study — & brings the most intelligent of the "Elementary School Girls" into the School!

5. Children's Hospital (Bristol) (established by Mr Whitwell) similar in character to Boston Ch. Hosp. Little children not suffering from contagious diseases are brought here. House accommodates about 40 and is nearly always full.

Bright pleasant rooms covered with pictures, toys & pictures in profusion. Little conservatories outside each window containing flowers & birds or a bird — or a squirrel. Nurses seem kind & gentle — and altogether the hospital impresses one as doing a good work.

Girls' School only in operation 3 years so that none have left yet. Boys' school has been in successful operation for 20 years. Boys' school under private management entirely. Girls' School under management of Board of Education. Girls taught Sewing — housework — cooking &c. Boys chop wood & learn shoe making. These in addition to ordinary education.

Every boy touches his hat as you approach. Every girl curtsies. Upon entering girls' School room all rose saying "Good afternoon Sir" in concert. They repeated the sentence because there were two of us and remained standing during our visit. As we left the room "Good bye Sir — Good bye Sir" floated out after us — sung in concert by all pupils.

The history of children preserved and after leaving school they are encouraged to write to the Superintendent. One boy went to Canada — soon sent out for his aged mother and has lately written to have a boy sent out to him — to give employment to — that he may show his gratitude to the School.

N.B. Steps of Investigation

definitions

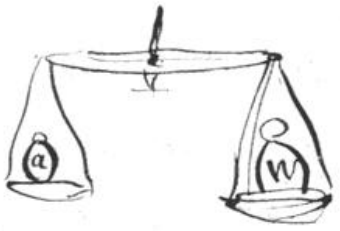
The "absolute weight" of a body is its weight when subjected only to the earth's attraction.

The "effective weight" is the tendency to move towards the earth — when all disturbing influences are taken into account — or perhaps "resultant weight" might be better.

The "apparent weight" is the weight indicated by a balance.

For instance

Suppose a body W weighing 5 lbs to be subjected to an upward attraction (equivalent to 1 lb) by the moon or other attracting body. Then



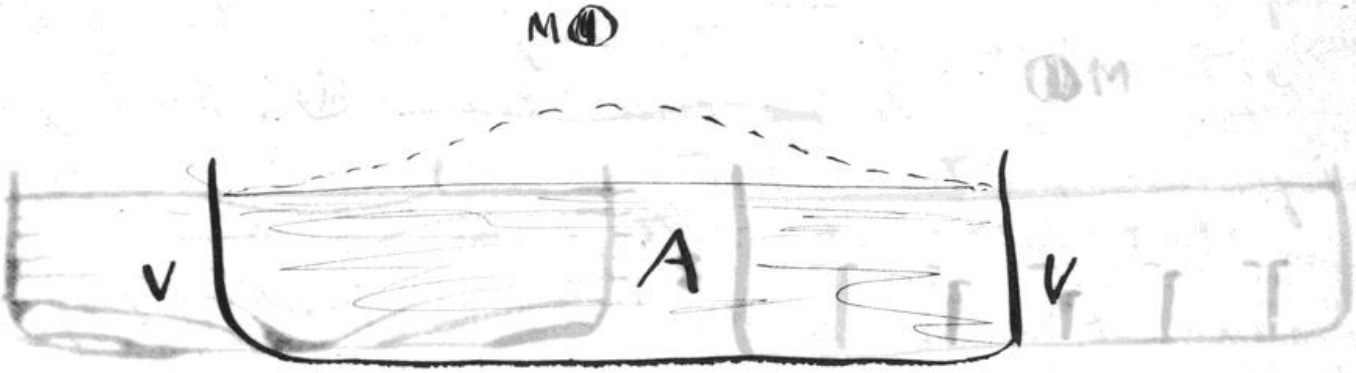
Absolute weight of W. = 5 lbs
Effective weight of W = 5 − 1 = 4 lbs
Apparent weight = 5 lbs.

The balance is incompetent to show the change in W's weight caused by the attraction of M because both scales of the balance are equally affected by M. The weight a man loses as much of its weight as W and the balance remains unaffected by M.

The Mercurial barometer is a species of balance in which the atmosphere is balanced by a column of mercury. The merc. bar. is therefore incompetent to record changes in the weight of the atmosph. due to the sun's attraction of the sun and moon. The mercurial column will lose as much weight as the column of air.

Sept. 8th 1877 — London —

Research continued from page 8



Effect of attractive body (M) on fluid A.

1. The fluid A under M ~~will~~ rises in the form of a wave or bulge as shewon by dotted lines
2. The fluid under M is not pulled up by the attraction of M — but is pushed up by the weight of the ~~bo~~surrounding columns of fluid.
3. The pressure upon the bottom of the vessel is everywhere the same after the bulge has been completed.
4. The mercurial barometer ~~would~~ indicates ~~a maximum~~ ~~under M and~~ unequal pressures upon the bottom of the vessel — the maximum pressure being ~~towards~~ under M.
5. During the rising of the bulge the mere. bar. under M rises and those furthest away fall — so that there is a transference of fluid from the low barometer to the high.

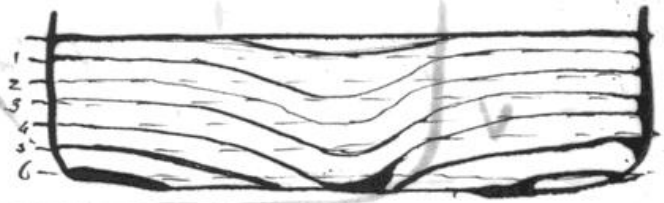
I

1.

M

II

2



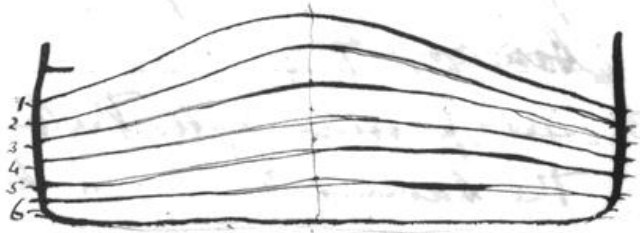
III

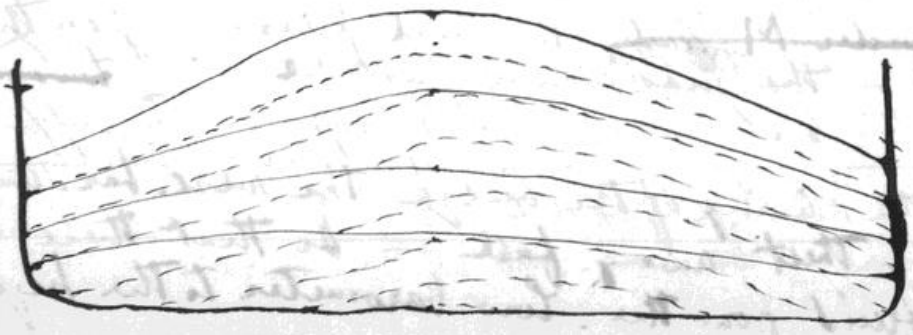
M

M

IV

4





The following steps of the investigation may be noted.

I Condition of fluid before M makes its appearance. (Stable equilibrium)

II Condit. of fluid when M makes its appearance. (Unstable equilibrium)

III Motion of fluid during restoration of equilibrium

IV. Condition of fluid after equilibrium is restored.

These processes are graphically illustrated on opposite page in two ways. Left In Roman Letter diagr. the sea or effective ~~weight of the~~ pressure upon the bottom is indicated by vertical lines thus (I) and the apparent pressure or barometrical reading thus (⋮)

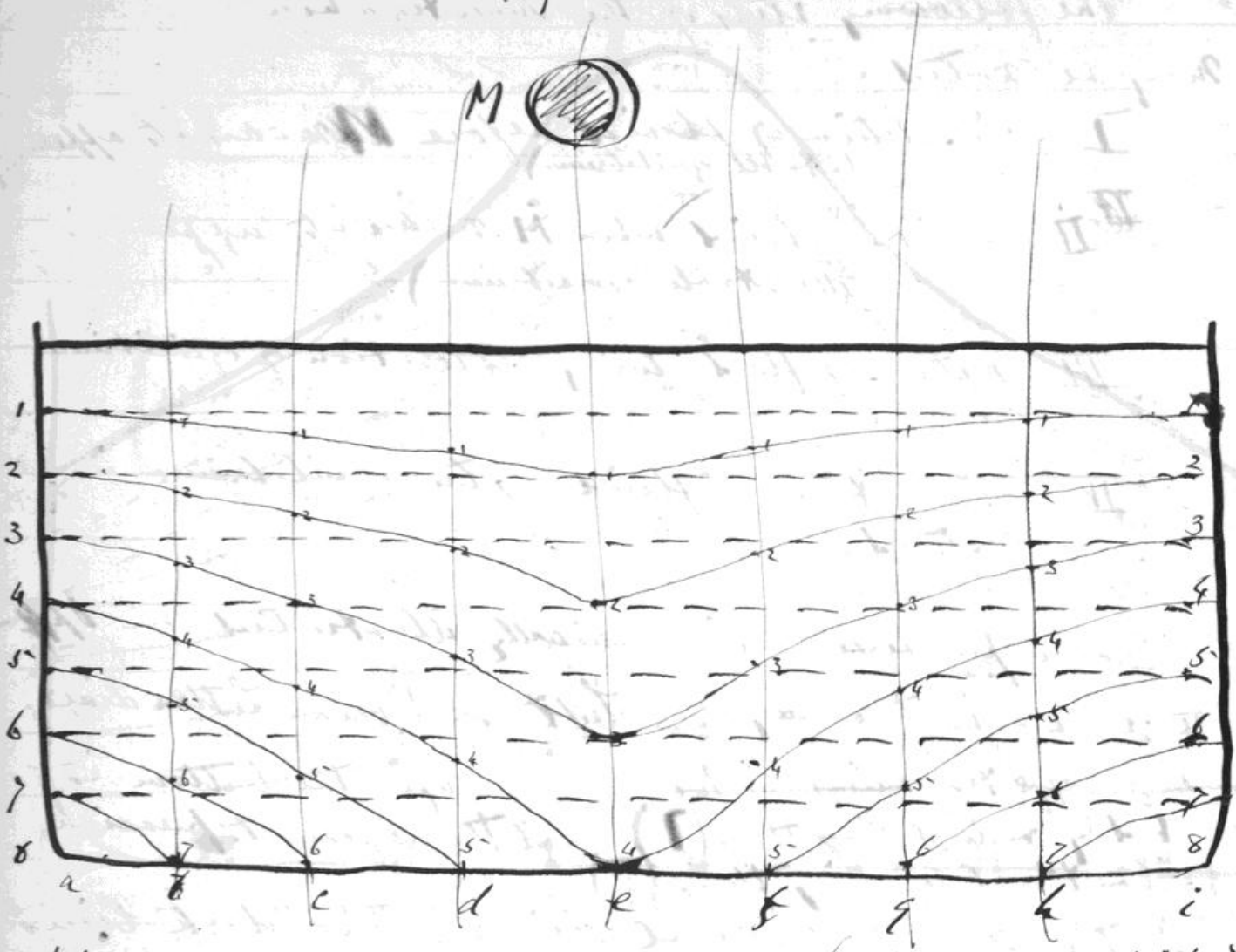
In the arabic numeral diagr. The dark lines show the true iso-barometric lines or lines of equal pressure. The dotted lines show the apparent isobars.

Attach values to pressures & results:

Let A = 8 lbs to square inch and let M's attraction be equal to 4 lbs. Let upward effects at stations a b c d e f g h i be equivalent to

a = 0
b = 1
c = 2
d = 3
e = 4
f = 3
g = 2
h = 1
i = 0

Fig 1



When the moon makes its appearance over (e) the distribut. of pressure is as shown in diagram by continuous lines but barometer indicates equality of pressure as shown by dotted lines.

Hence while barometer gives no reason for movement of fluid – a motion takes place – The heavier columns pushing up the lighter

Motion can be represented as follows

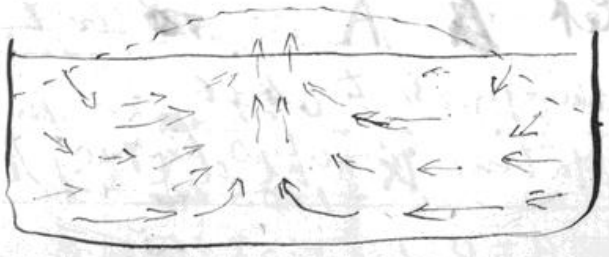
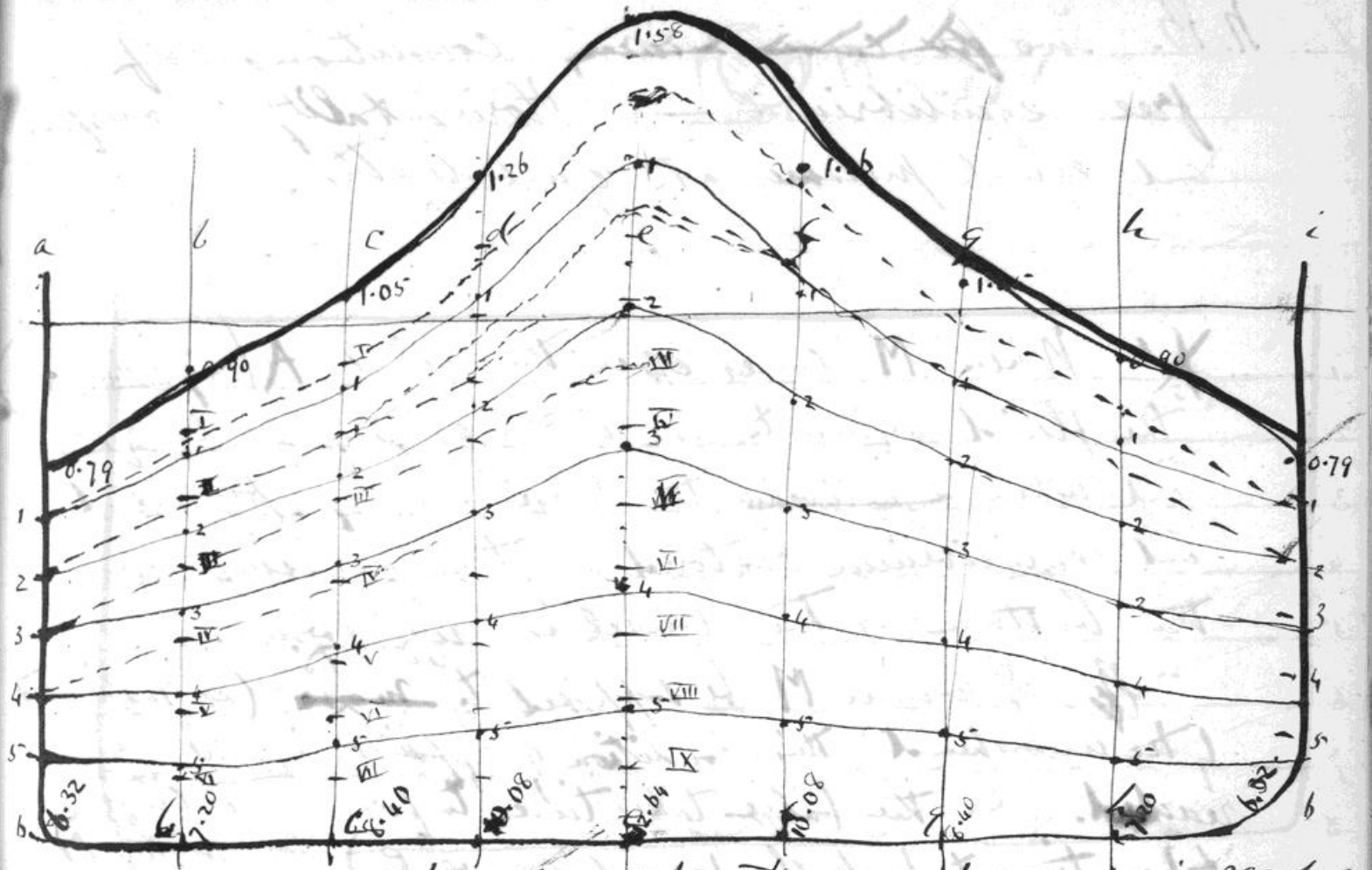


Fig 2



Equilibrium will be restored when the mean pressure is reached at the bottom that is when the pressure $= \frac{8+7+6+5+4+5+6+7+8}{9}$

Mean pressure = 6·3 lbs

~~Finding these~~ To find the new ~~height~~ height of the liquid at any point (a,b,c,d,e)

old height (Fig 1) : new weight (6·3 lbs) :: old height (fig 1) : new height.

$$\therefore \text{New height} = \frac{6\cdot3}{\text{old weight.}}$$

$$\text{New bar. pressure} = \frac{(\text{old bar. pres}) \times \text{new height}}{\text{old height}}$$

New height for		(new barom. pres.)		. new height
a	= 0·79	6·32 lbs	i	= 0·79
b	= 0·90	7·20	h	= 0·90
c	= 1·05	8·40	g	= 1·05
d	= 1·26	10·08	f	= 1·26
e	= 1·58	12·64		

Counting pressure at bottom 6 lbs and weight distributed uniformly upwards The isobars will be as shown in fig 2.

N. B. Two ~~conditions~~ conditions of free equilibrium — Horizontality of surface and equal pressures at equal depths.

When M comes over the spot A (fig 2 page 19) the fluid begins to rise in the shape of a bulge and when ~~equilibrium~~ the bulge is fully formed and equilibrium restored — the pressure on the bottom of the vessel is uniform.

If however M be supposed to be moved (as indicated by the arrowhead) this condition of affairs is never reached. For the bulge takes time to form — and before it has time to be fully formed above (C) the moon M has passed off to another point 5. Hence equilibrium is never fully restored — and the pressure under M is always less than elsewhere — though the depths of fluid is ~~the~~ water.

Next point — what happens when M has passed away altogether?

After bulge has been formed as on page 19 — and equilibrium been restored — ~~let M disappear~~ let M be removed.

Liquid is raised under moon until pressure at bottom of vessel is uniform. But then surface is no longer level. In fact ~~the~~ isobars are not horizontal. Hence the liquid of the bulge has a tendency to overflow adjoining columns & restore horizontality of surface. This is prevented by attraction of moon. As shown on page ~~the~~ the attraction of moon can be considered as resultant ~~compound~~ of two other forces acting vertically & horizontally.

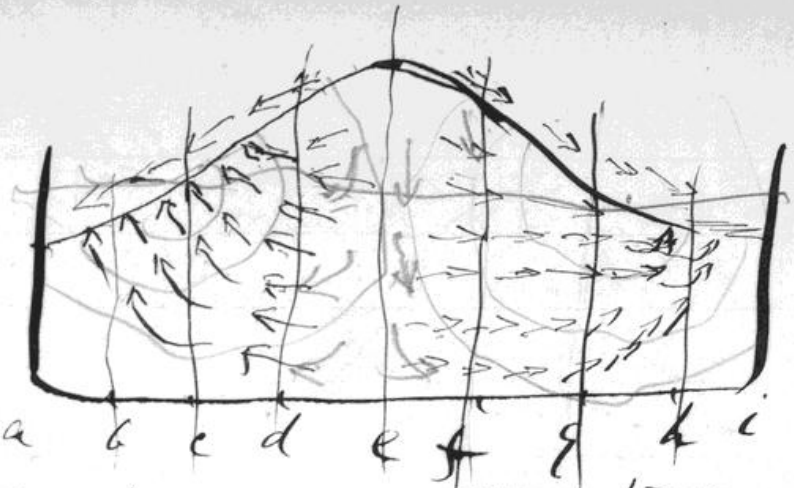
The horizontal component acts in opposition to overflow tendency of bulge and thus keeps liquid in stable equilibrium although surface is not level.

Same result follows with all isobars which are bulged up under moon. The overflow tendency is counteracted — and the whole liquid remains ~~at rest~~ in equilibrium.

~~Sept.~~ 9th 1877 — London.

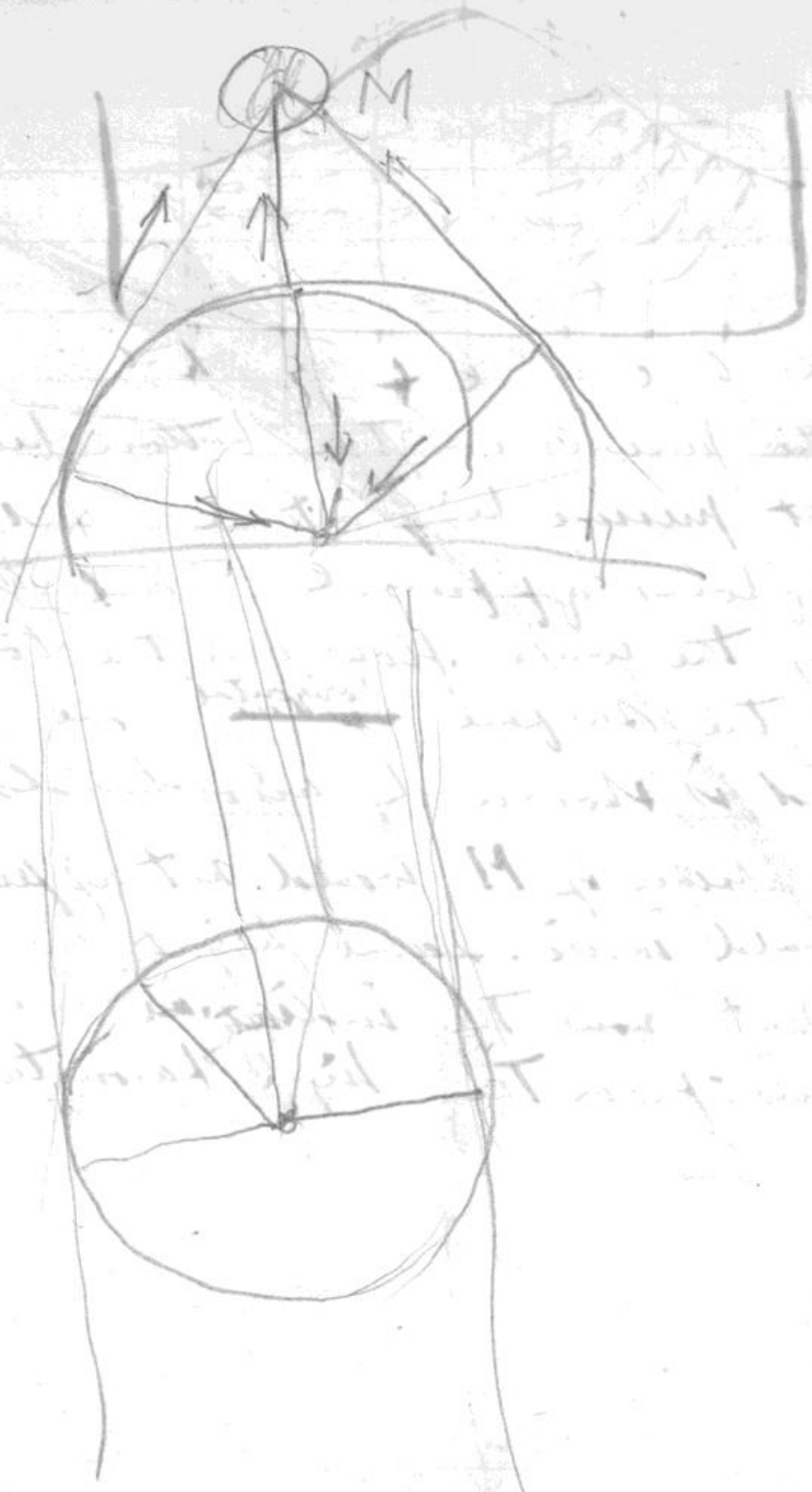
It is evident from the foregoing investigation that the Mercurial barometer is unreliable as a means of observing changes ~~due to~~ of pressure due to the attraction of the sun or moon. X

~~When the Bulge~~ When the moon comes over ~~place the air displaced up in the~~



At once the pressures on the bottom become unequal. The greatest pressure being at e — and the fluid therefore flows off from e — and the higher portions of the mass flow over the lower so as to make the surface horizontal. The motion of the fluid is shown by arrowheads.

The absence of M would not affect the barometer which would indicate same height as when M was present. But now the indications are correct and the fluid flows from the high barometer to the low.

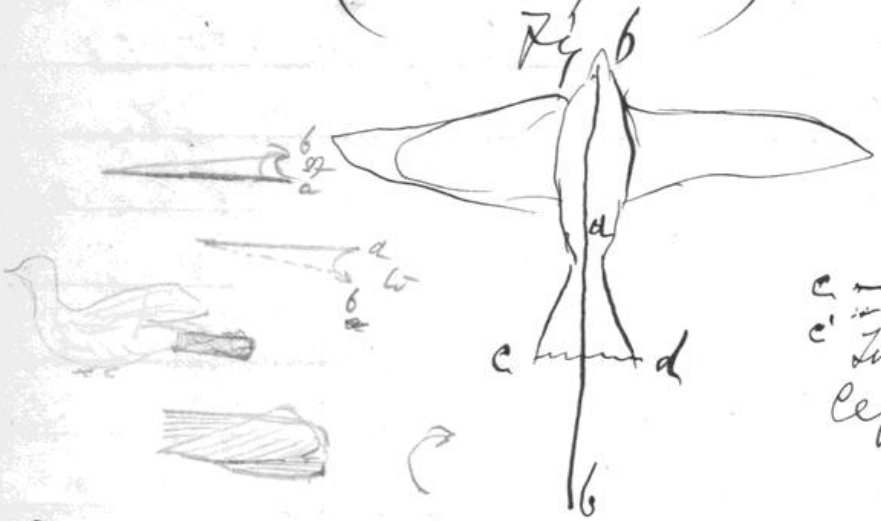

M

Sept. 18th 1877

Continuation of research upon influence of attractive body upon a fluid. Very depth of liquid under moon for instance: ——

Take half depth of fluid. — wave raised would be only half height.

X Illustrations Figs 3 & 4 do not seem clearly to show the action of tail. The tail did not move towards the right or left — but turned upon an axis (so to speak). Take line ab



as the "axis" of the birds tail. The tail ~~rocked~~ turned upon this axis towards the left ~~when~~ the bird went to the left.

Call the end of tail c d in Fig 6. Then Figs 7 and Figs 8 illustrate action in turning. Frequently the tail would go rapidly from position c'd' (Fig 7) to c' d' (Fig 8) and vice-versa — a number of times as if to balance the body.

October 6th. 1877. Went to Rhuseaulen Abbey yesterday and had splendid opportunity of studying the flight of the hooded crows that inhabit the ruin. Two or three hundred crows performed their evolutions only a few feet above my head. Noticed some points concerning the use of the tail in flight. The tail in rapid ~~and~~ straight forward flight was horizontal and narrowed. When performing their gyrations it was spread out like a Lady's fan and inclined as in diagram.

Fig 1

Rapid & straight flight.

Fig 2

When turning

Fig 3

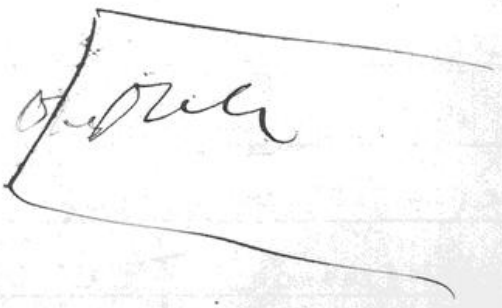
Tail turned as shown – made bird move to the left.

Fig 4

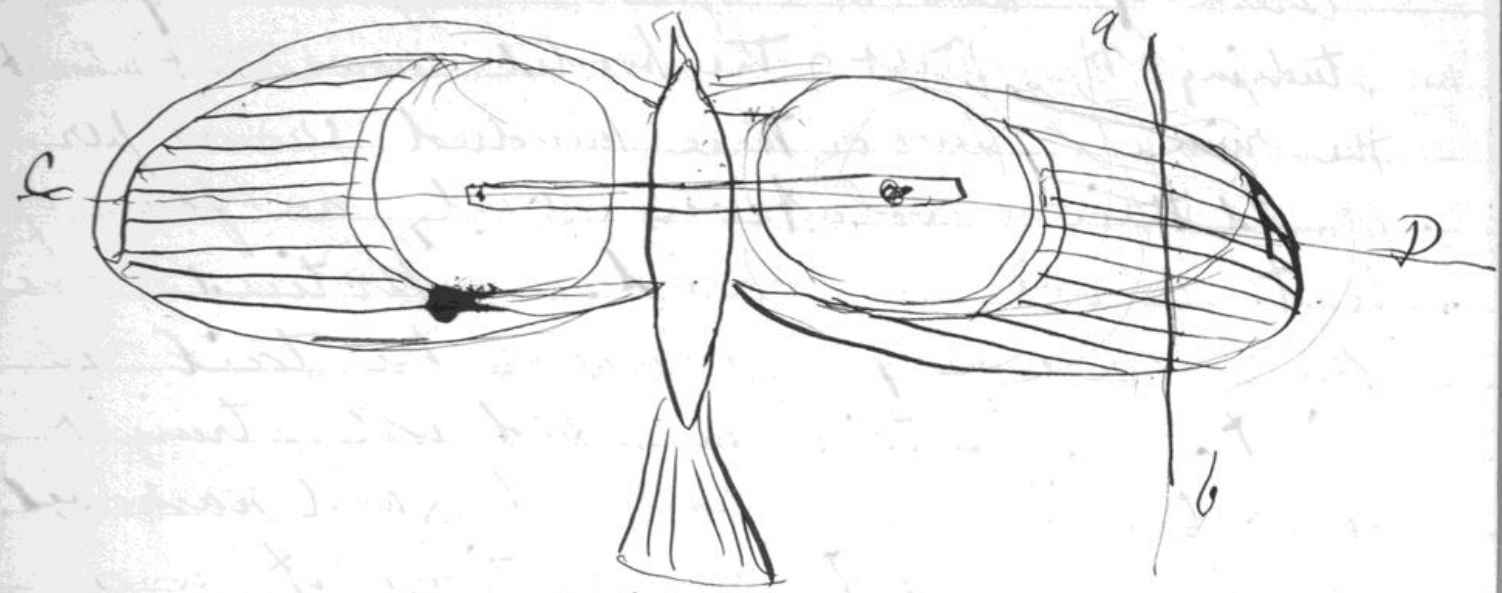
Moving to the right

Fig 5

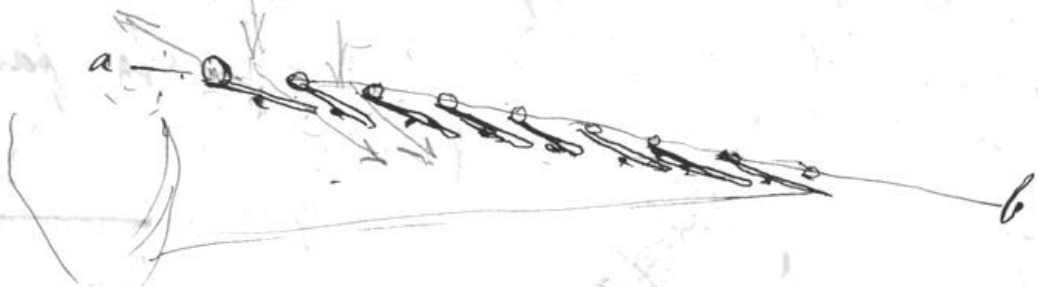
Stopping.



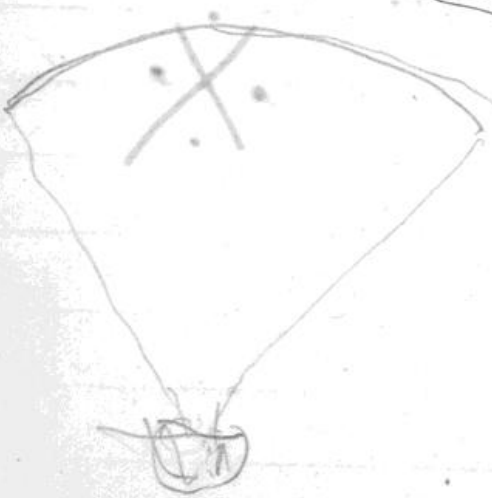
Machine devised up to date



Section a b



Section C D

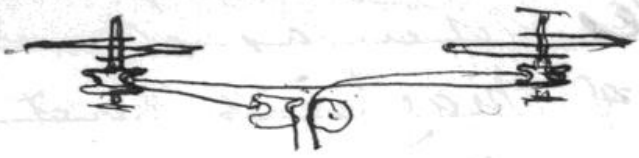


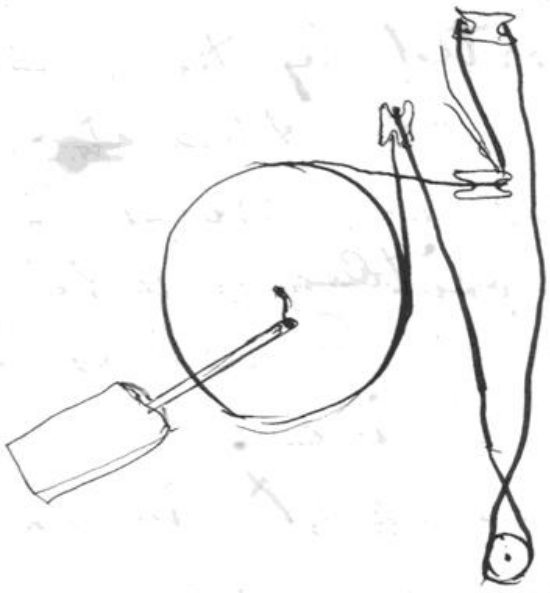
hinged
parachute

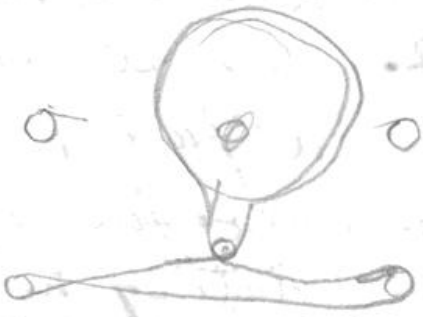
Oct. 6th 1877 Aerial navigation.

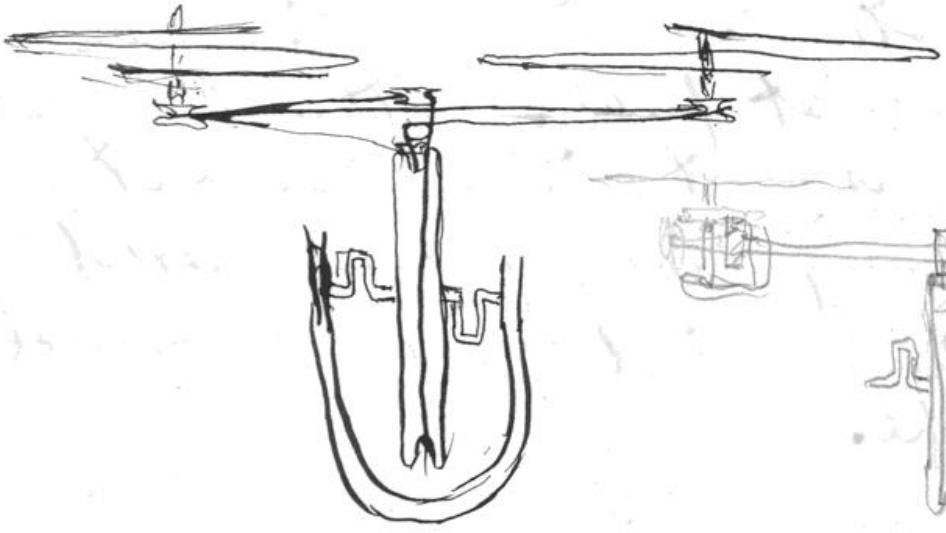
Principles upon as developed,

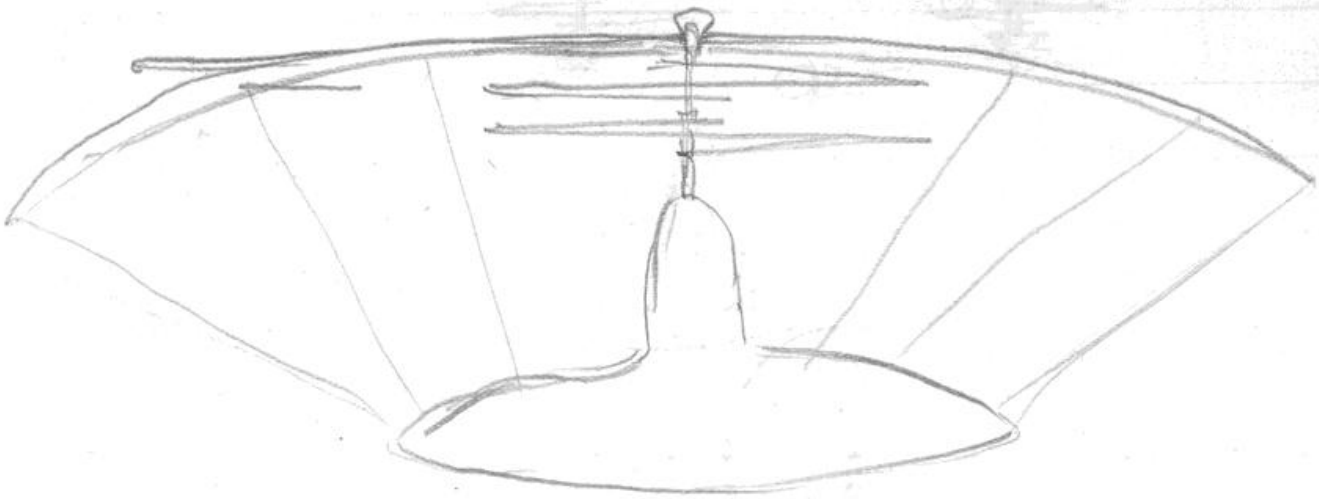
1. ~~Body~~ ~~Steam~~ machine must be specifically heavier than air.
2. To be supported by the revolutions of a fan wheel or screw.
3. Two fan wheels or screws to be used rotating in opposite directions — so as to neutralise each others turning action upon the engine.
4. Parachute arrangement in case of accident to machinery.
5. If steam-engine motive power used — hence light fuel — Either oil or gas.
6. Perhaps hot air engine best & lightest.
7. Or carry store of compressed air.
8. Perhaps bird offers best model for shape.

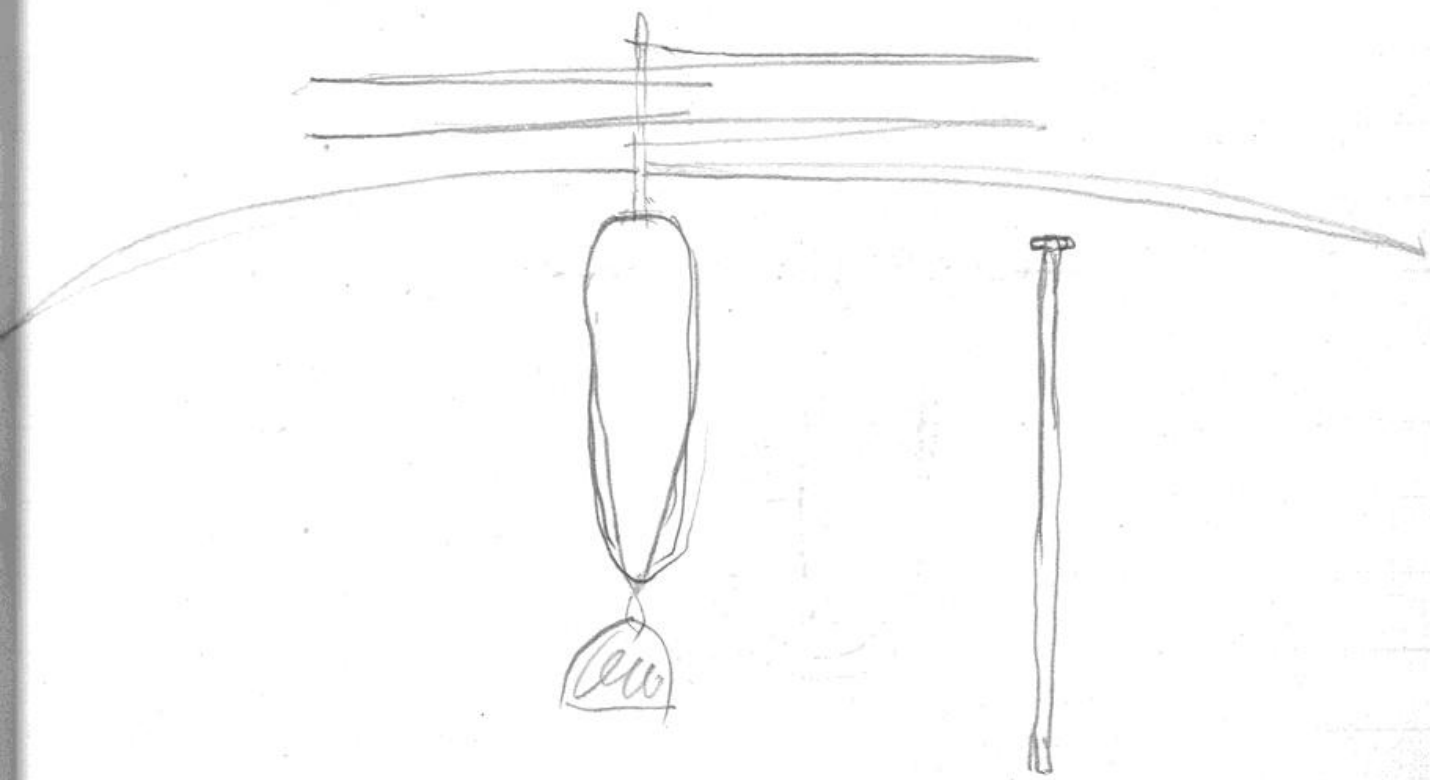




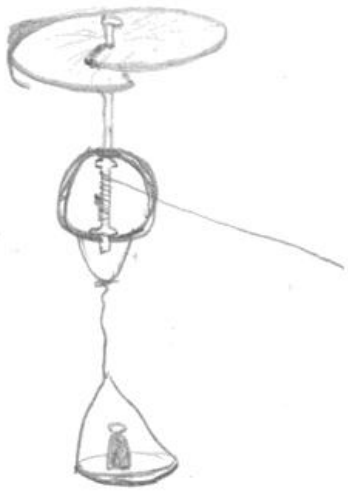


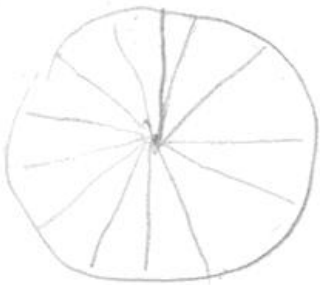


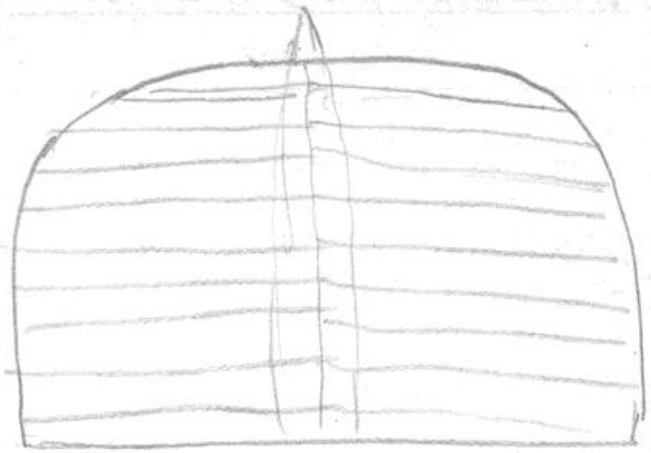


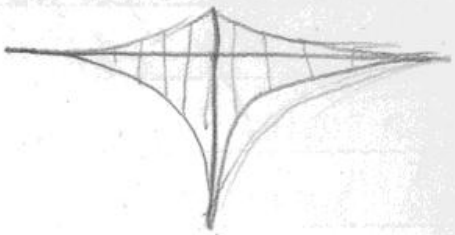


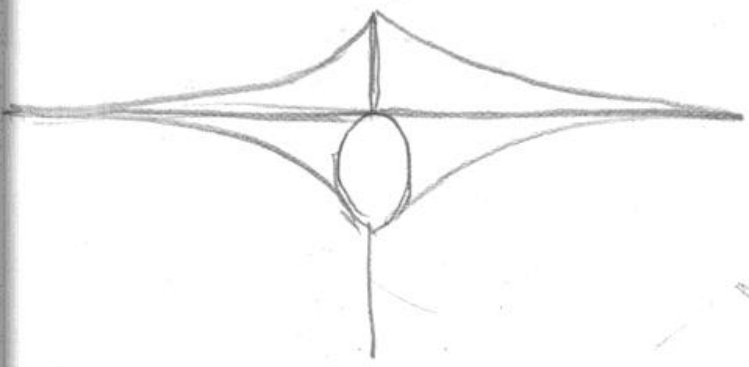
To test lifting power of screw — Hence instrument made as in diagram.

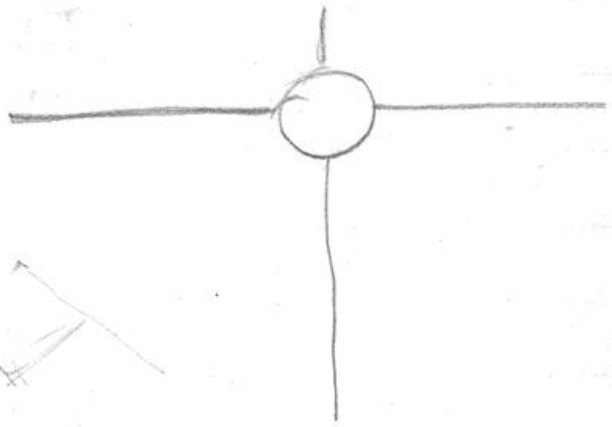




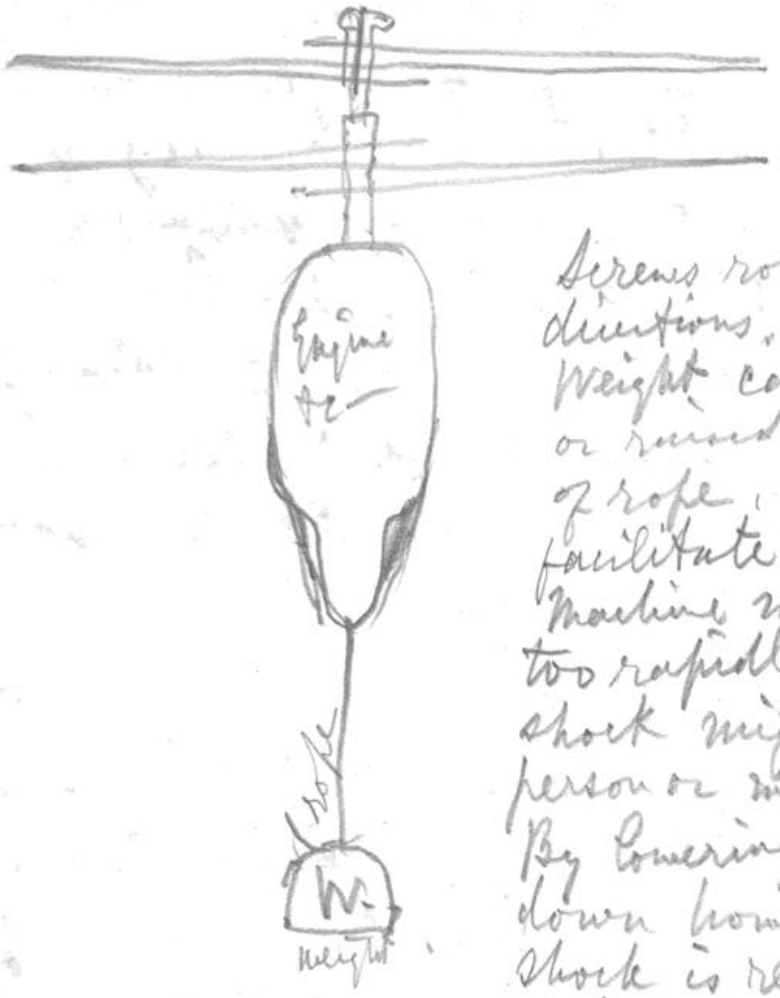








Oct. 10th Most feasible shape if supporting power can be obtained is probably this ?



Screws rotate in opposite directions.
Weight can be lowered or raised by means of rope. Weight to facilitate landing. Machine might descend too rapidly and the shock might injure person or machinery mounted. By lowering a weight down however — the shock is received by the weight if the descent is too rapid — and the machine being lightened descends gently a little way by the momentum of descent & then rises to the limit of the rope.

(1.) The rope can be pulled in till the machine is brought down to the ground when the rotation of the screws may be gradually stopped.

(2) Or the rotation of the screws may be gradually

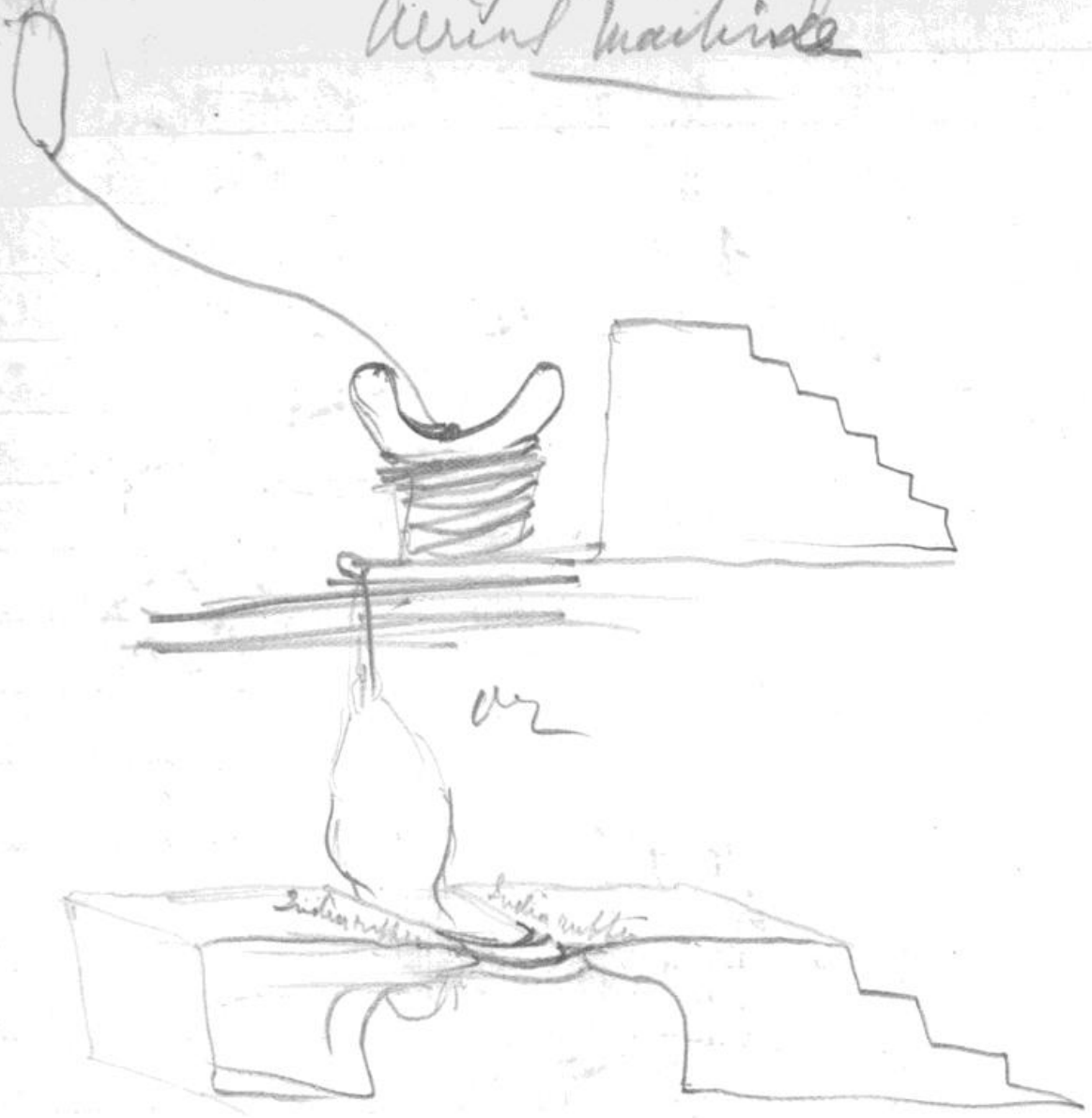
diminished until machine touches ground.

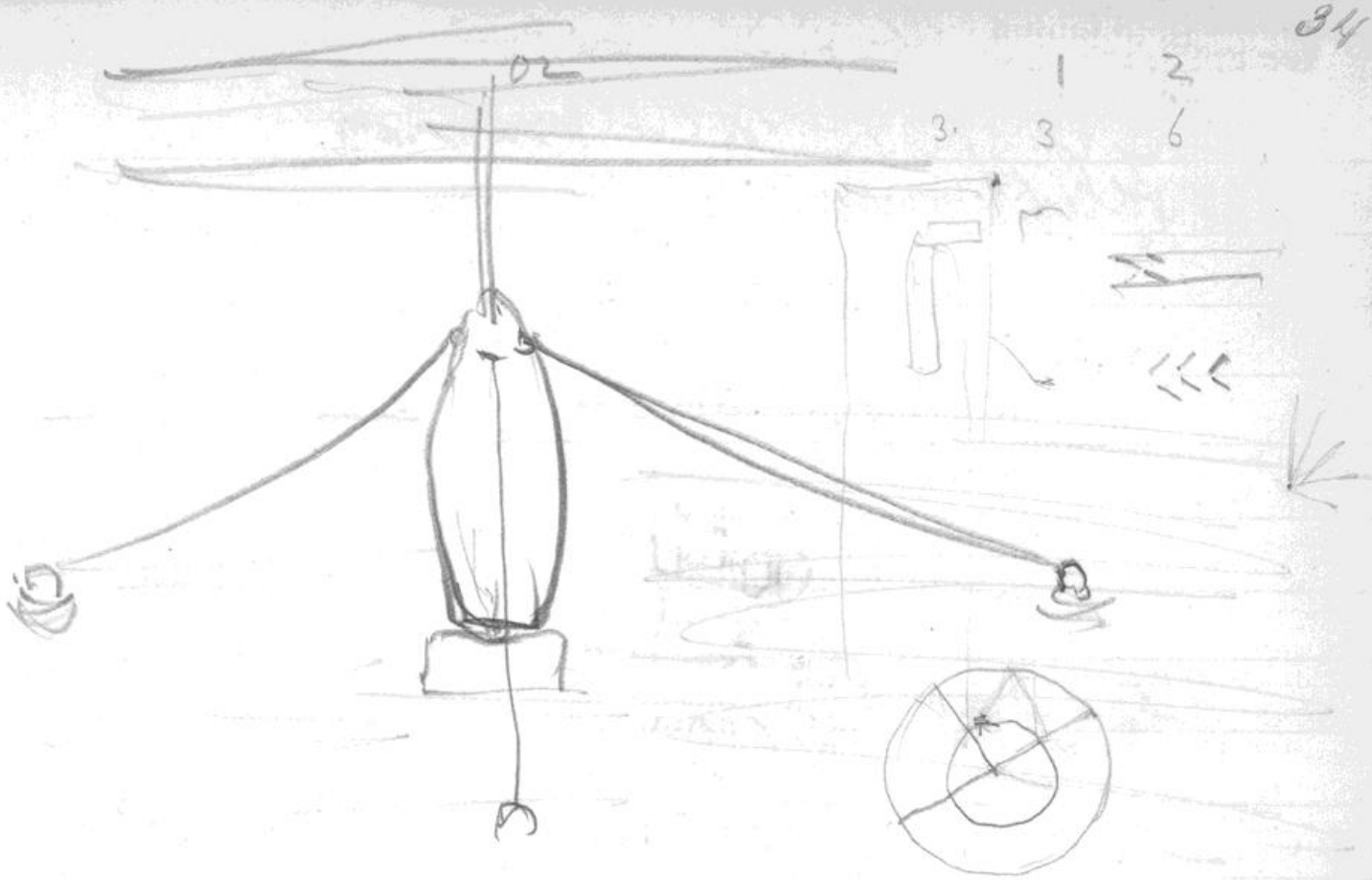
(3) Or rope ladder may be let down from engine and passenger descend. In such a case if the weight on ground did not exceed weight of said passenger it would be necessary for him to hang on to rope ladder until the rotation of screws had been sufficiently reduced to permit of his leaving go — otherwise the machine being suddenly lightened would rise & carry off weight & all. This third plan would be safest for the machine itself.

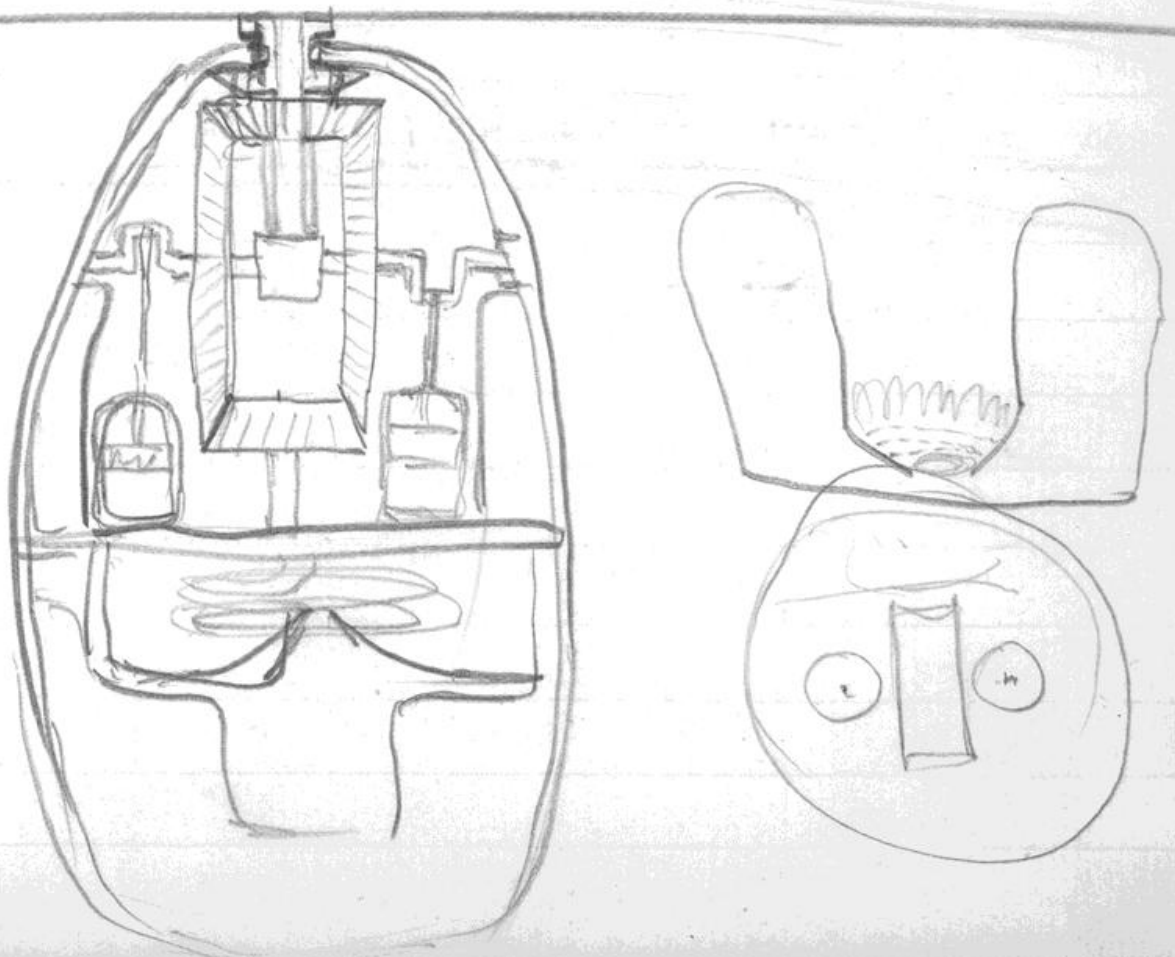
(4) It would be advisable however to have stations properly arranged for alighting. For instance taking shape of machine as indicated — Have ~~a~~ ~~rope~~ or buffer arranged on springs of proper shape to receive machine, ~~and~~ let a rope be let down from machine to a man whose duty it is to attach it to centre of buffer. People in machine (or below) pull machine down to buffer & then rotation of screws is gradually stopped.

33

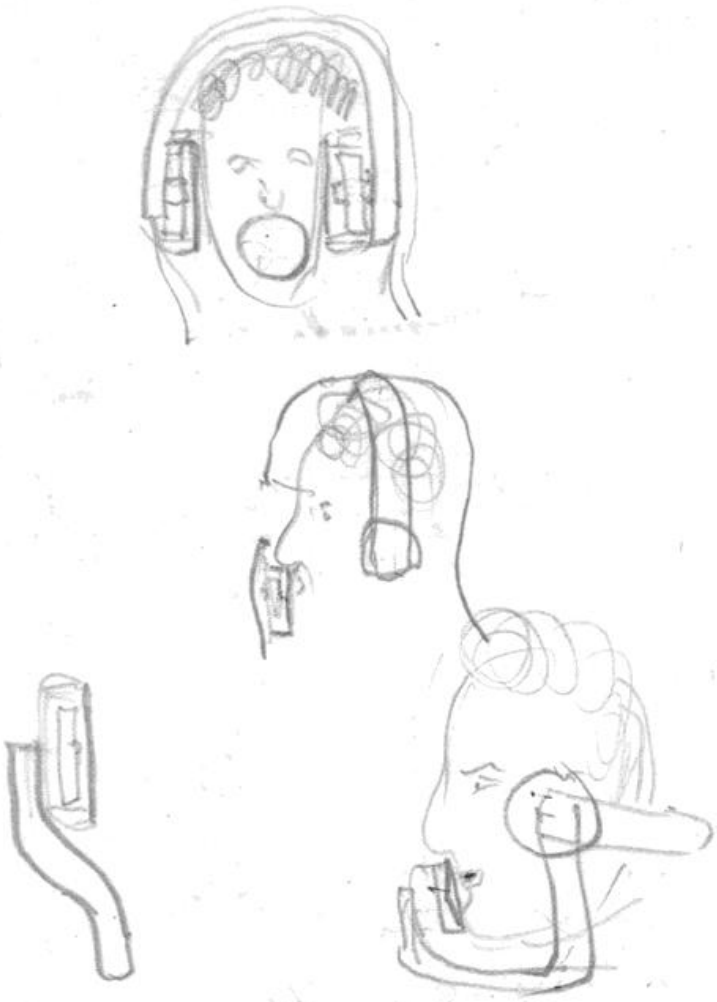
Receiving station for aerial machines




02
1
2
3.
3
6



Diver's Helmet with Telephones



Information derived from the Misses Richards of St. Andrews Oct. 12th 1877

John or James Bell
m. —

Catharine
m. William Richards

Catherine
Martha
Margaret
Bellville

David
m. Isabella Swan

Alexander Bell
m. Elizabeth Colville
of Galdrie

David
Wm. Robertson
Elizabeth

Archibald
m. — Margary Spence
Cousin of Lord Jeffrey

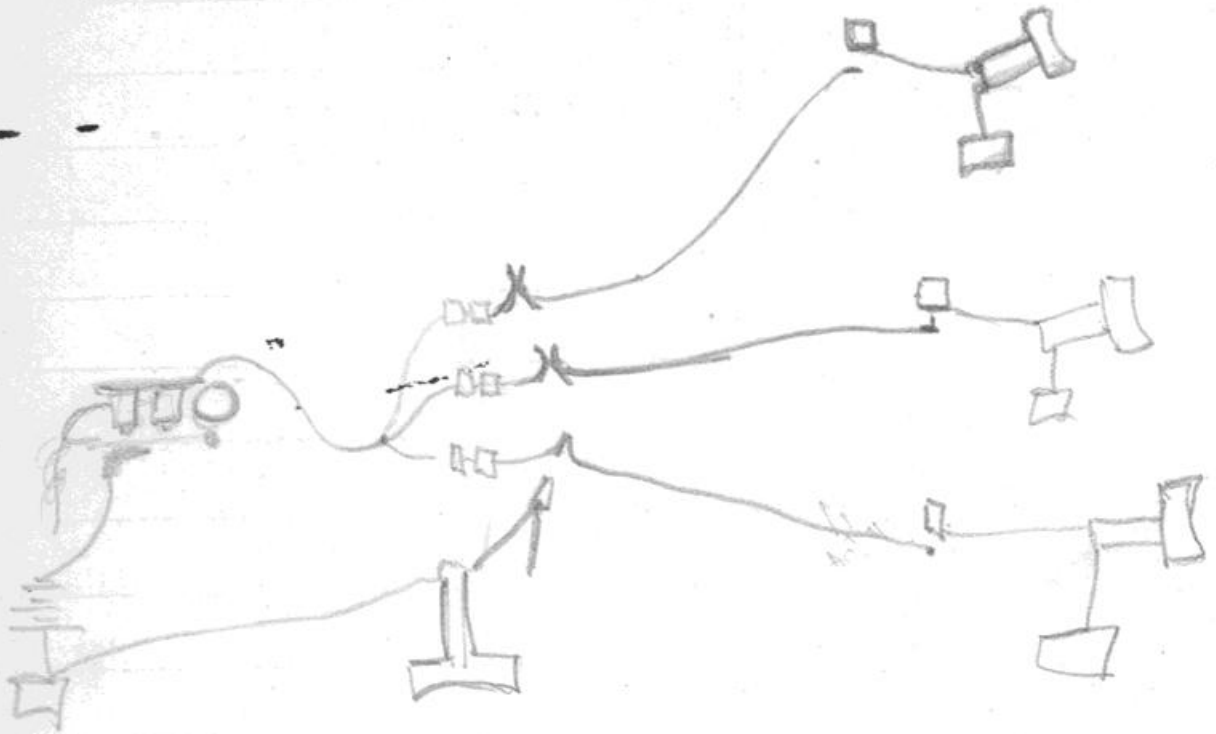
James Bell
m. — Buchanan

James Bell
m. —

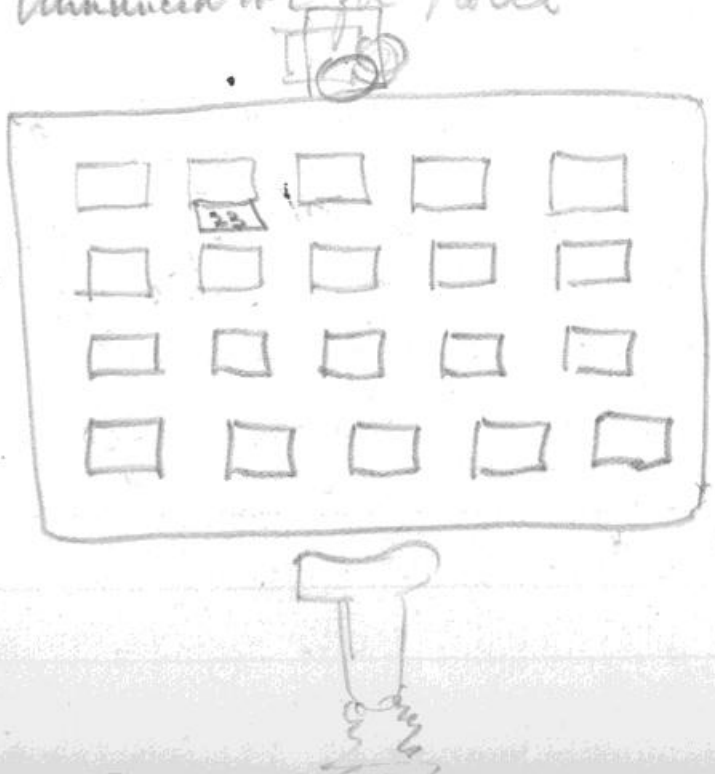
Archibald Bell
m. —

Stated that Mrs. C. Wallis wife of present Editor of Scotchman is same relation to a.g.b. that the Misses Richards are.

Art. 13 [illegible] Connections for Hotels
Telephones - Bells &c.

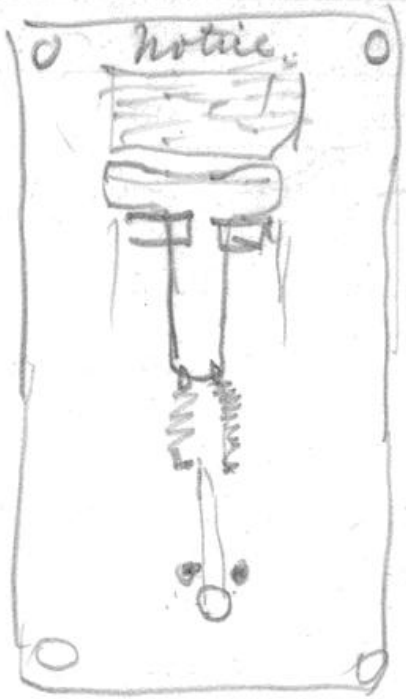


Annunciator for Hotel



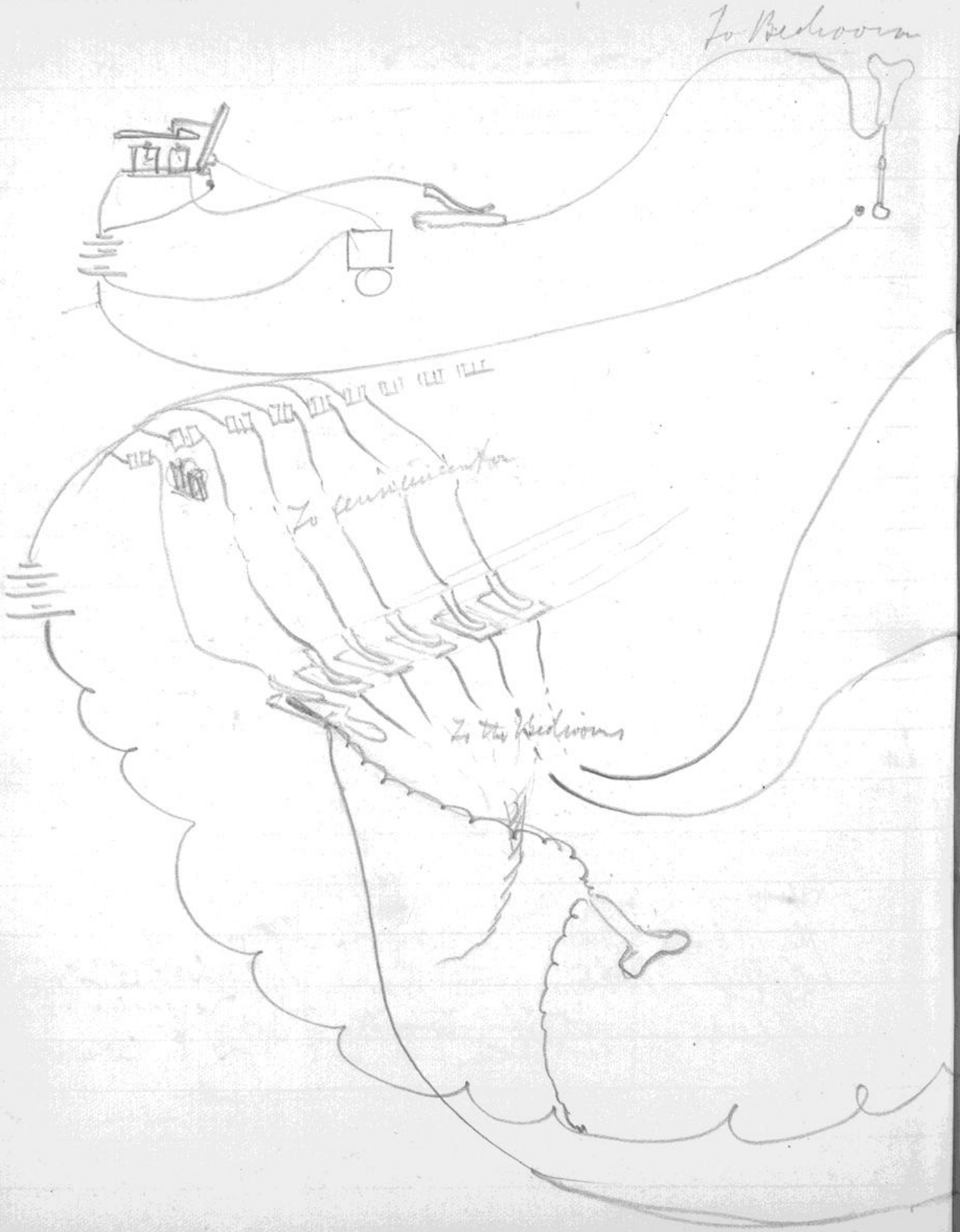
Hotel

Connection in Bedroom 07

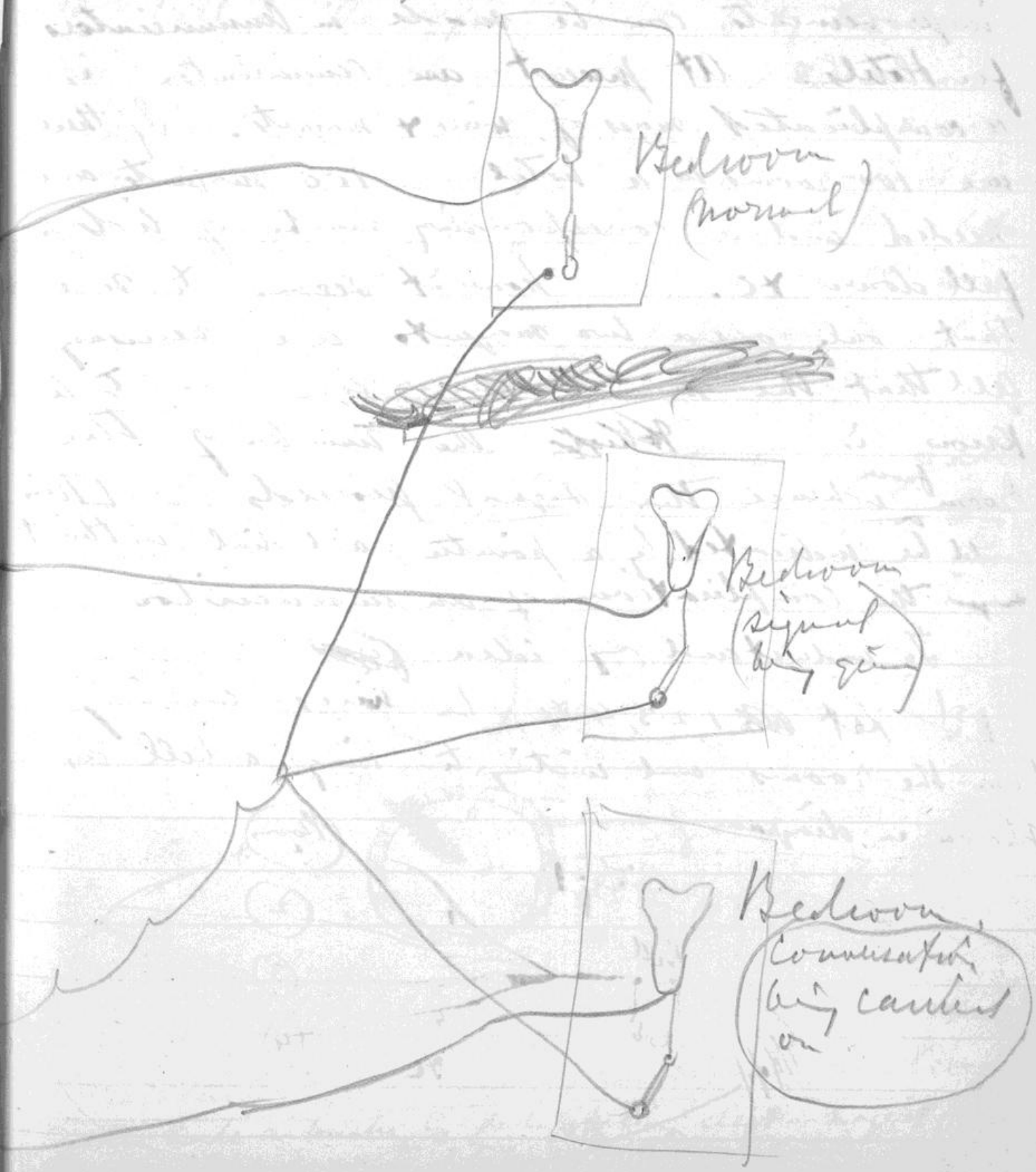


Notice

Turn the switch to the left and place the Telephone to your ear. Wait till the bell stops ringing and until the attendant asks what is wanted. Then put the Telephone to your mouth and speak. When you have finished replace switch to the right.


To Bedroom
To Servants Quarters
To the Bedrooms

Telephone Connections for Hotels.

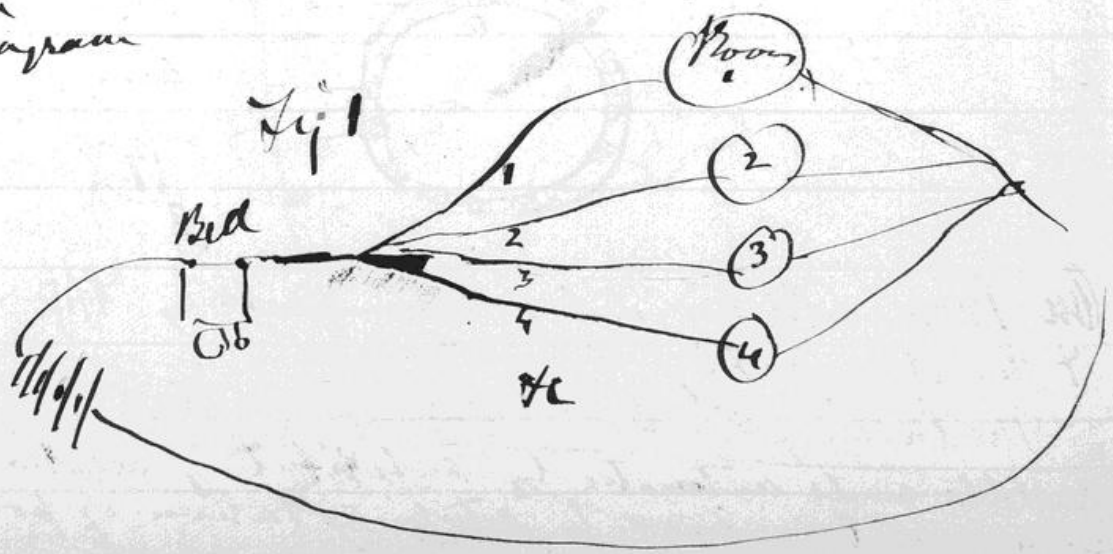


Oct. 16th 1877 It strikes me that great improvements can be made in Annunciators for Hotels. At present an Annunciator is a complicated mass of wires & magnets. If there are 100 rooms in a hotel — 100 magnets are needed and a corresponding number of bells to fall down &c. Now it seems to me that only one or two magnets are necessary. All that the men in the office want to know is — the number of the room from whence the signal proceeds and this could be indicated by a pointer and dial without the complications of an annunciator.

To understand my idea

1st Let 1, 2, 3, 4 &c be wires coming from the rooms and uniting to ring a bell as shown in diagram

Fig 1



Now when a signal is made in Room (3) the bell in the office rings but the attendant does not know which wire the current comes through. If however he had a galvanometer & could introduce it alternately into the various circuits at 1, 2, 3, 4 &c. no deflection would be obtained except when it is in circuit with wire 3. He therefore knows that signal proceeds from Room 3.

Arrangement for introducing galvanometer into circuits alternately.

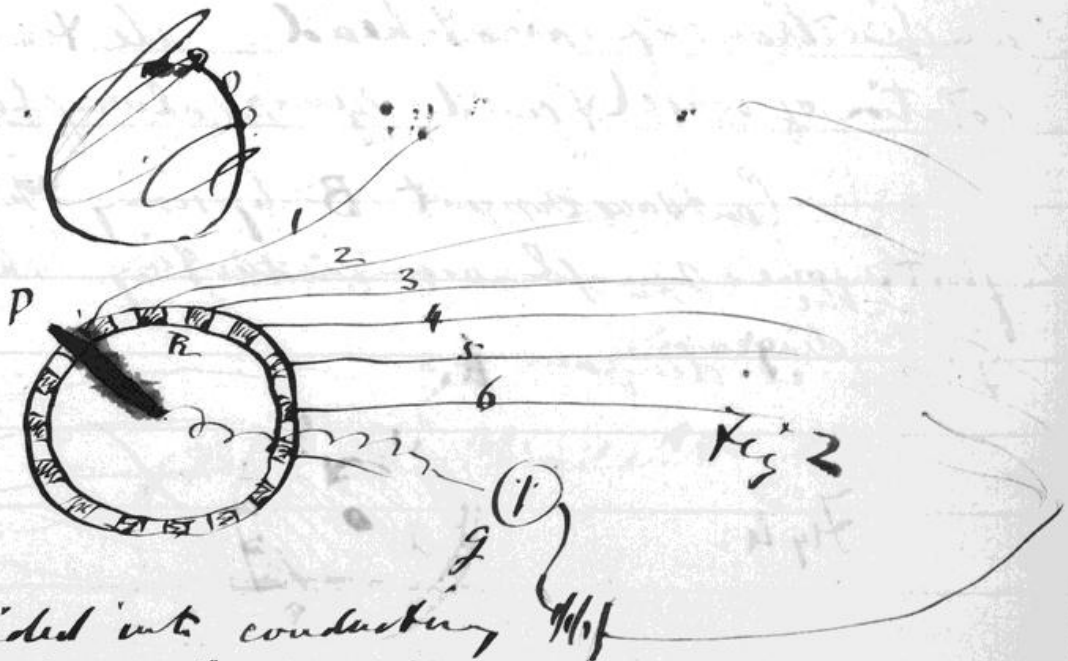


Fig 2

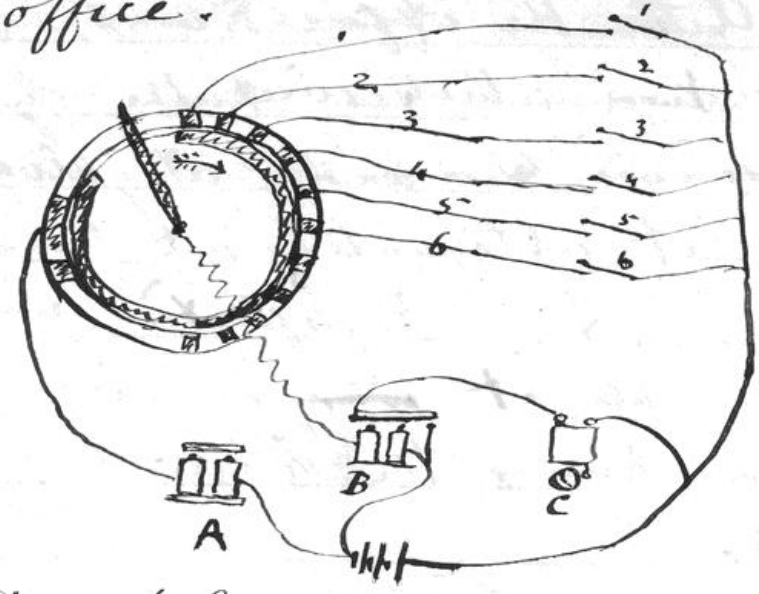
R. The Rim divided into conducting & non conducting segments.

P. Metallic pointer connected with galvanometer g.

Could be made automatic by substituting electro-magnet for galv. Arrange armature so as to stop rotation of pointer when current passes — The pointer would then indicate the number of room.

Automatic Annunciator requiring two magnets and a bell in office.

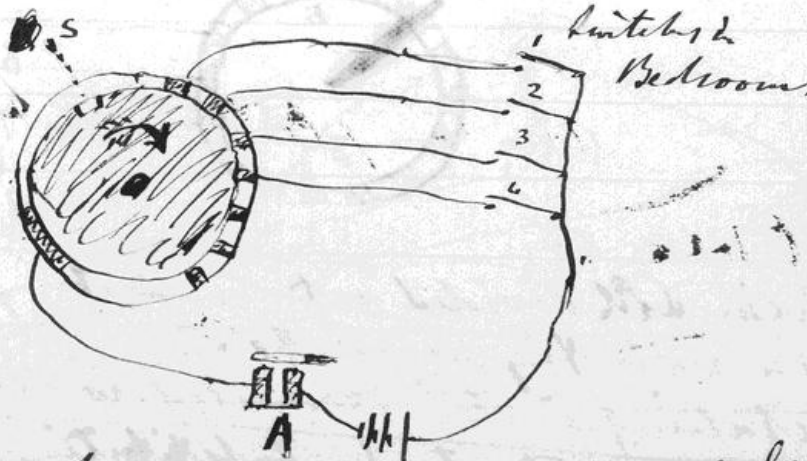
Fig 3



The shaded parts of the wheel and rim are metallic. Pointer also metallic. Electro-magnet A employs a release mechanism which will set wheel in rotation in direction of arrowhead. Electro magnet B stops rotation of wheel and rings alarm bell C.

Can save magnet B by using metallic wheel with one small non-conducting segment as in next diagram.

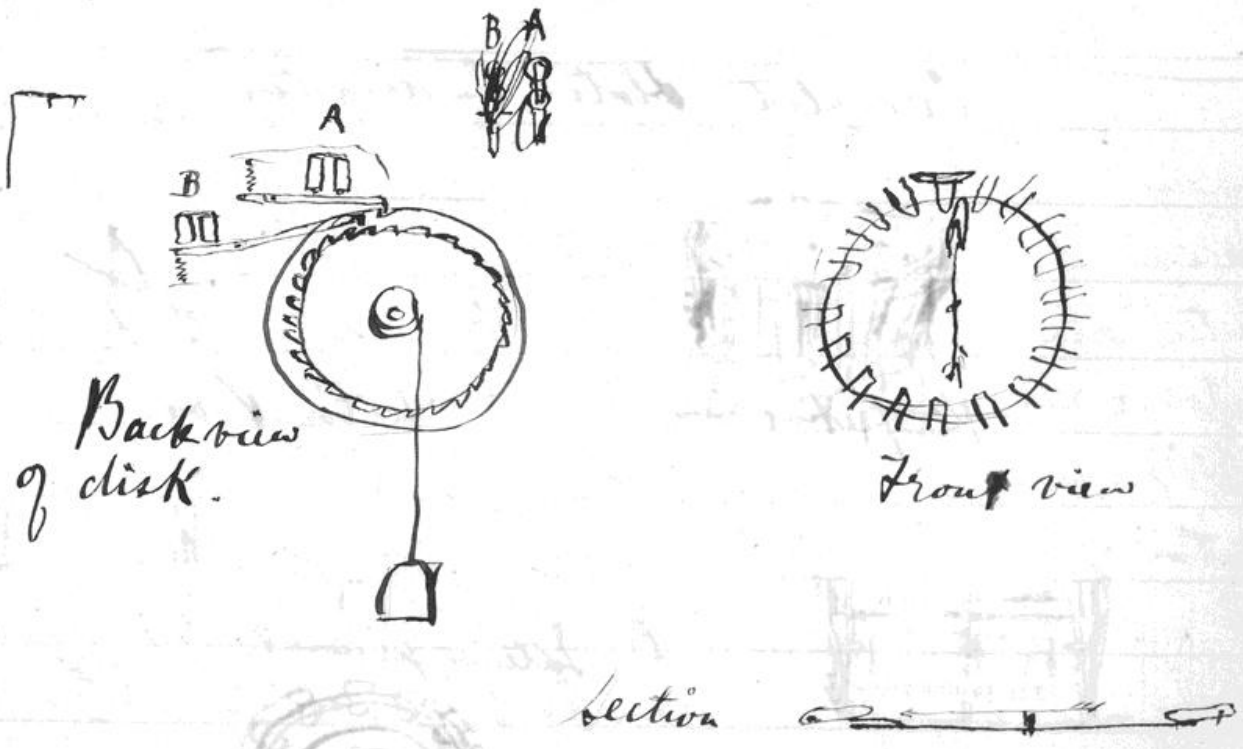
Fig 4



When current passes through magnet A armature releases mechanism that rotates wheel & rings bell. When current does not traverse A armature stops mechanism.

Upon second thoughts two magnets as in Fig 3 will be better as it might happen that two signals might be given simultaneously in which case the wheel Fig 4 would not stop at all.

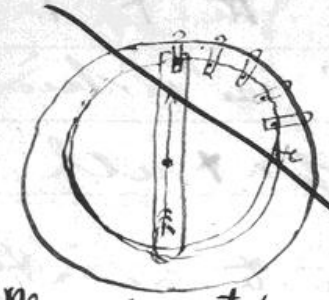
Let magnets A and B operate as in Fig 5 & 6



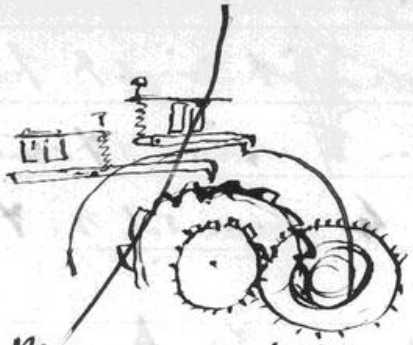
For complete instrument see

Over.

Over

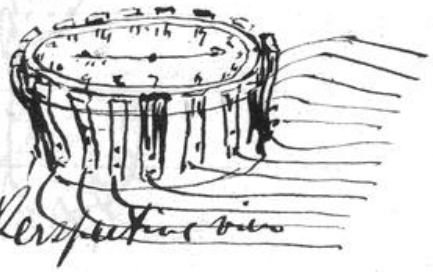


Plan view of top



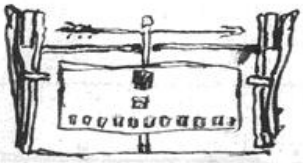
Plan view of interior

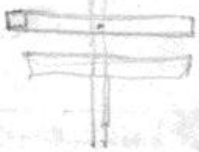
Complete Hotel Indicator



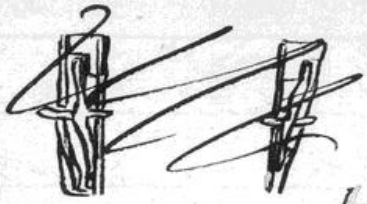
Perspective view

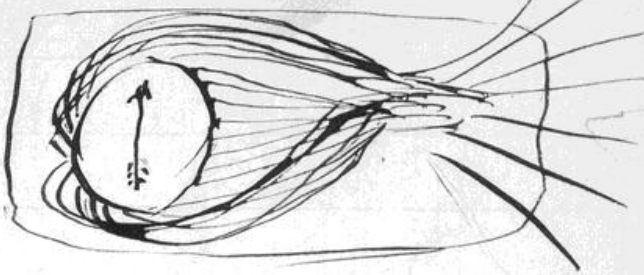
Sectional view



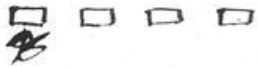


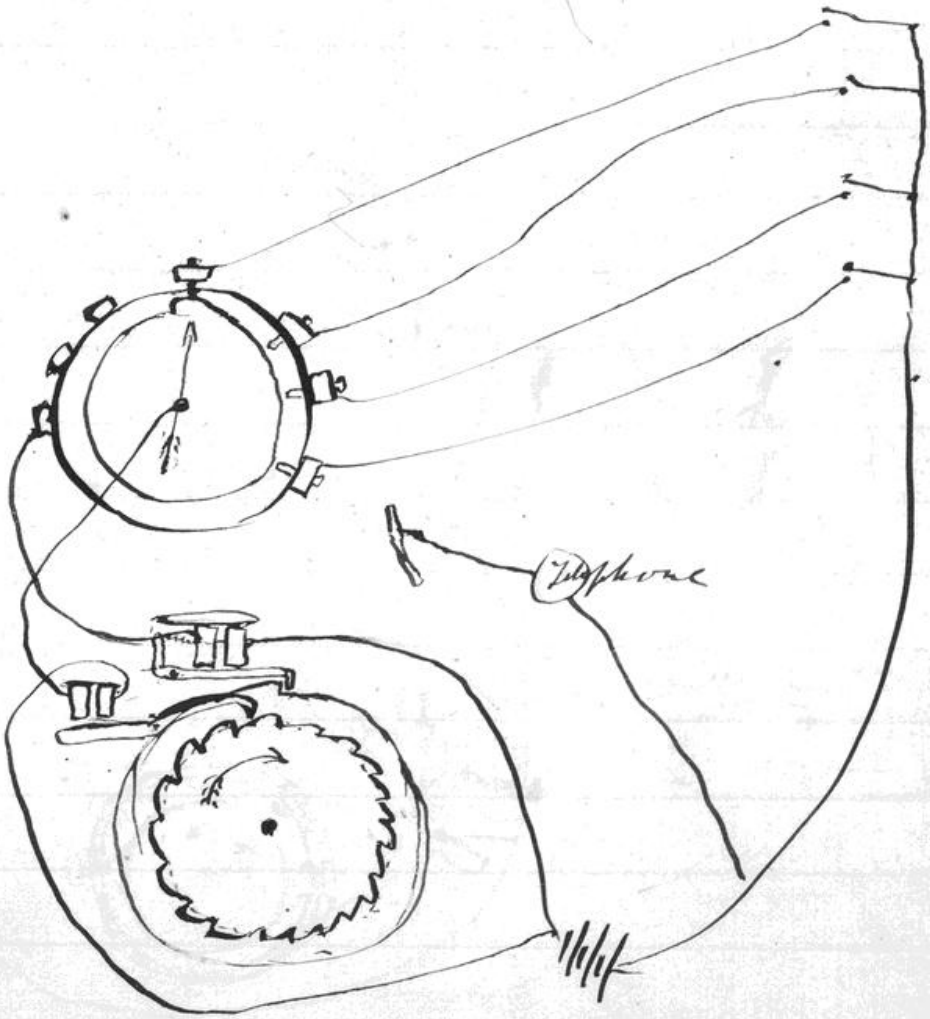
Interior plan

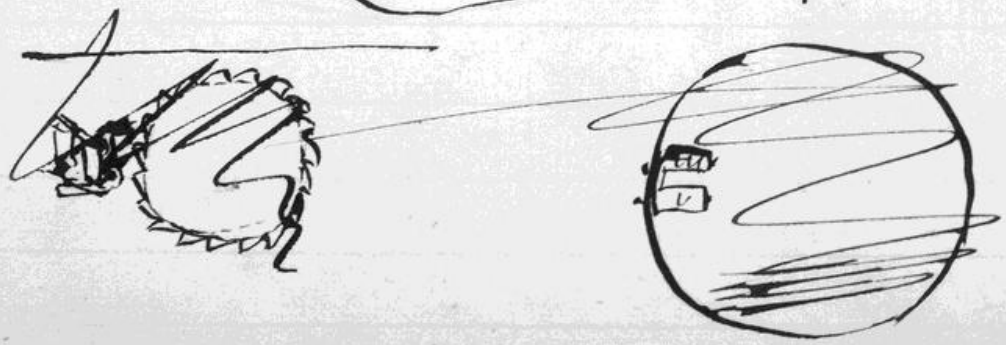


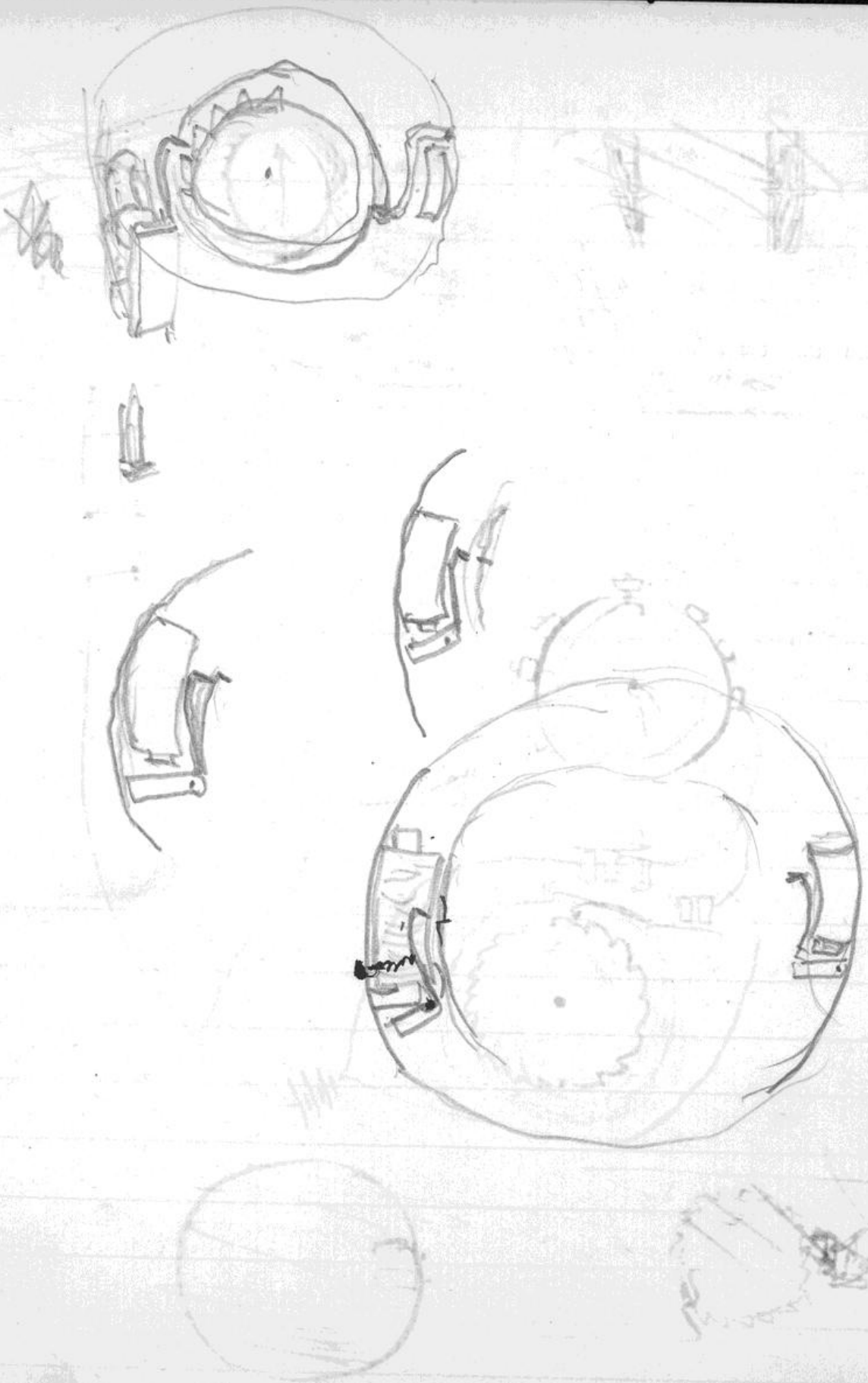


4/60
3/15
5-







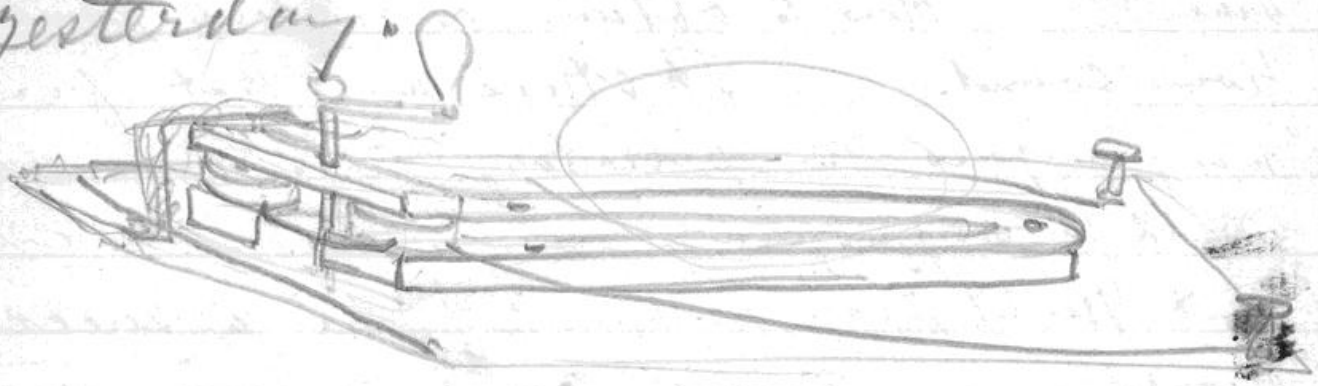


Mayat A

Mayat B

Oct. 15th - 1877 New call-bell arrangement

description sent to W. Hubbard yesterday.



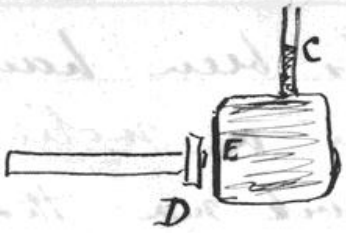
The simple difference is — have the coils upon the magnet instead of the armature — so that the complicating springs are un-necessary.

Oct. 27th. About oct. 16th a thought occurred to me that has been haunting me since. How to obtain a motive power from sound. It struck me that for many purposes the vibratory circuit-breaker would be inappropiate & uncertain — and that Multiple Telegr. to be a success should leave some more certain means of causing the audible signals to record themselves automatically or to work apparatus mechanically.

We know that liquids do expand under the influence of heat and we explain the process by supposing that the molecules are thrown in to vibration and thus strike the neighbouring molecules and the body as a whole expands. If this is true why should not fluids expand in a similar manner under the influence of a sound?

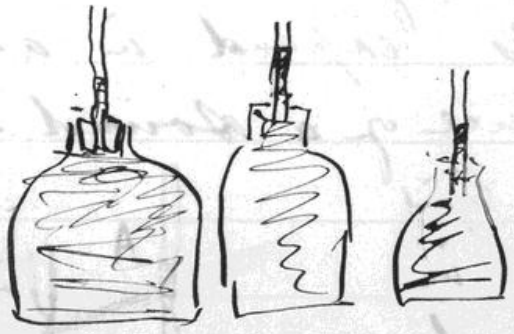
Experiment to try. Will liquid rise in tube A when water in vessel B is agitated by a sound as for instance when tuning-fork is presented to it.

If so the water in tube C could be made to push up a piston & open or close a local circuit when the Telephone D produces a Sound.



It seems to me that the plants would certainly rise in pipe (C) if a more sluggish fluid were employed than water e.g. glycerine — or even oil. I should think glycerine would be the thing for it could be diluted with water until the requisite degree of sensibility is obtained.

It is probable that every cavity filled with fluid has a key note of its own to which the liquid will respond — in which case a series of bottles could be arranged as follows

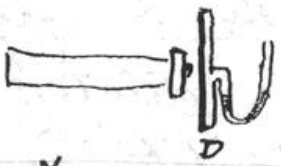


So that the liquid in each bottle would rise when a certain note is struck and no other.

Perhaps the expansion would be more marked in a ~~compressed~~ elastic fluid.

Try following experiment.

Telephone A. Air chamber B. ~~Siphon~~ Bent pipe C. Will fluid in pipe C rise when sound is transmitted. Try also Air cavity small as in D.

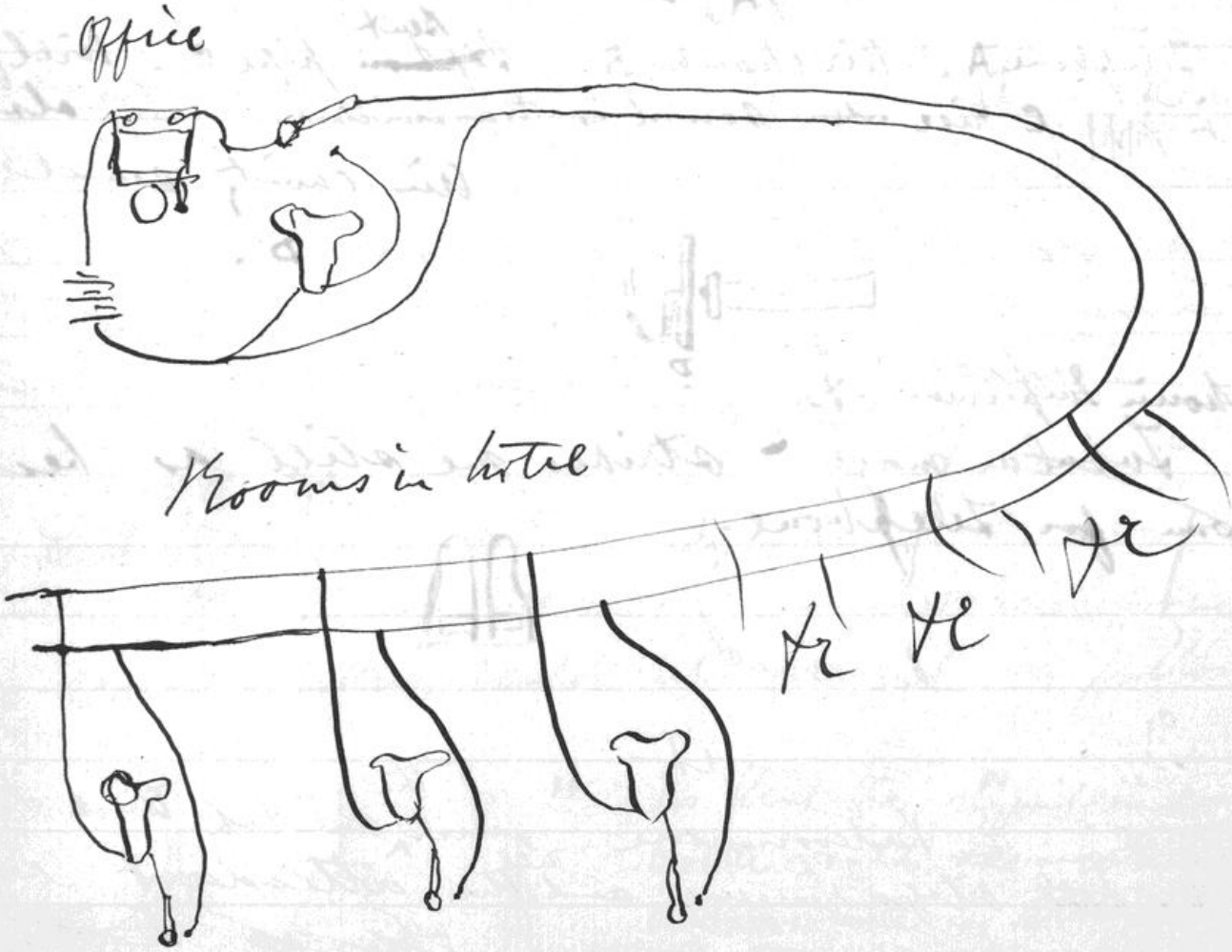


Telephonic Experiments

Tubular magnet strikes me still as best form for Telephone.

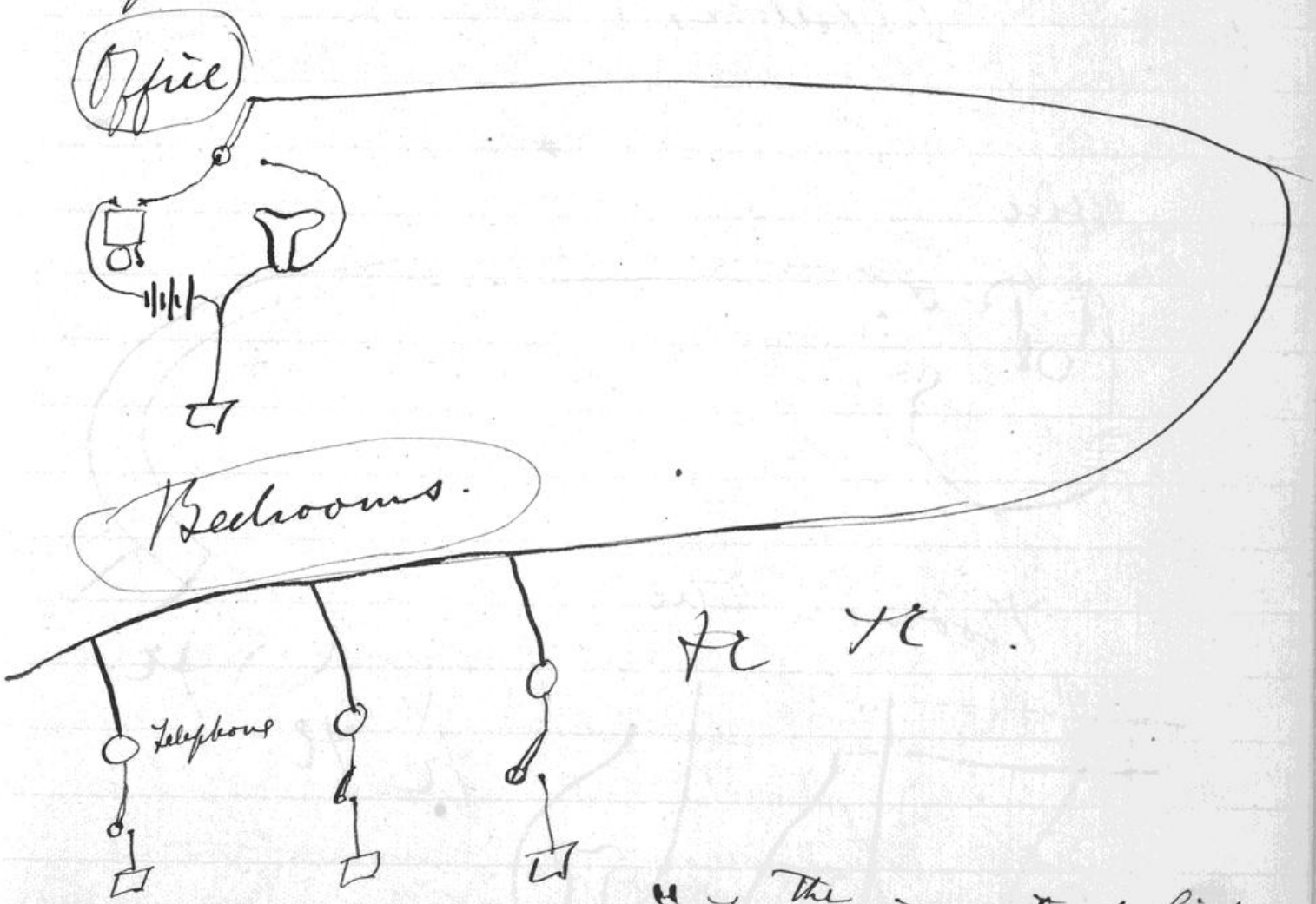
November 2nd 1847

Forwarded to Mr Hubbard a day or two ago a simple arrangement for house connections on hotel. As follows.



Of course return wire may be dispensed with and gas pipes or water pipes used instead.

Arrangement would then be



Directions in Bedrooms are. "Turn switch and listen till the bell stops ringing and the attendant asks you the number of your room. ~~Then ring the bell~~ Then tell the attendant what you want.

N.B. Remember in every case give the number of your room — Otherwise your orders cannot be attended to."

Nov. 6th 1877 - Expansion of fluids by sound continued.

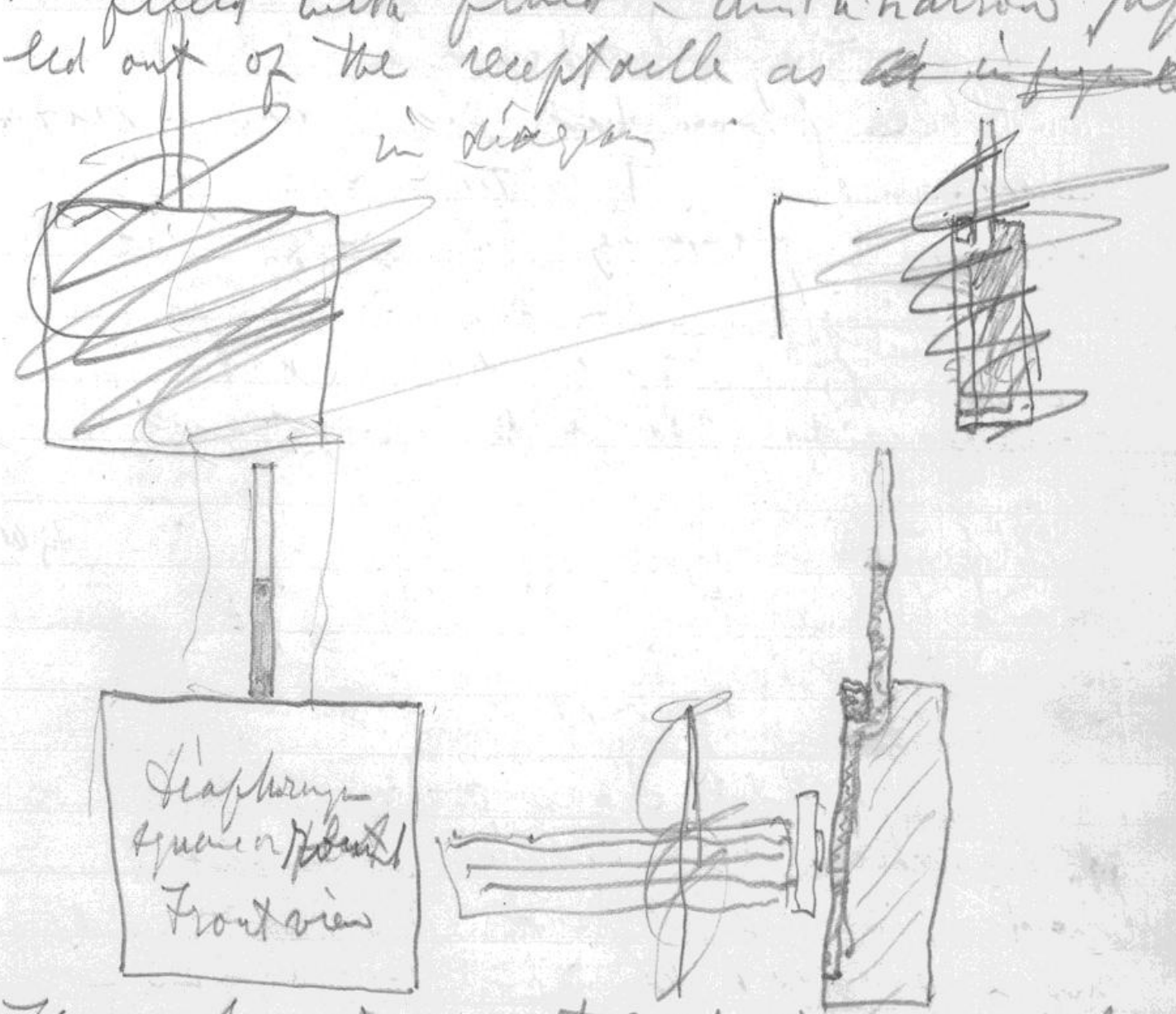
If fluid expands under vibration of sound — then the expansion should theoretically be proportional to the rapidity of vibration.

Hence a thermometer could be simply converted into a phronometer.

If the amplitude is uniform the liquid should rise with increased height of pitch — If pitch is uniform with increased amplitude

If for no other purpose liquid appliances to telephone could be made to operate a bell, &c. to attract attention. For instance with the Gray Telephones Model can feel the ~~vibrations~~ diaphragm move when the diaphragm at the other end is tapped by a pencil. Now if diaphragm formed one side of a receptacle

filled with fluid - and a narrow pipe led out of the receptacle as ~~shown~~ in diagram



Then when distant teleph. is tapped liquid would rise to coincid. height in pipe and could release mechanism or make electrical contact & ring bell.

Perhaps too the amplit. of vibration of liquid in pipe might be greater

than diaphragm & the sound of ~~operating~~ speaking be more audible from ~~the~~ pipe than from membrane. Worth trying.
This may be the action of present apparatus — in which case the sounds would be louder when an incompressible fluid is employed.

Upon consideration it seems to me that liquid can be made to rise in pipe to a different height when A is agitated by a sound by retarding the motion of fluid — so as to render its ~~action~~ motion more sluggish than that of the ~~sound~~ sound vibration. In which case the principle of the action is the same as vibrating circuit breaker.

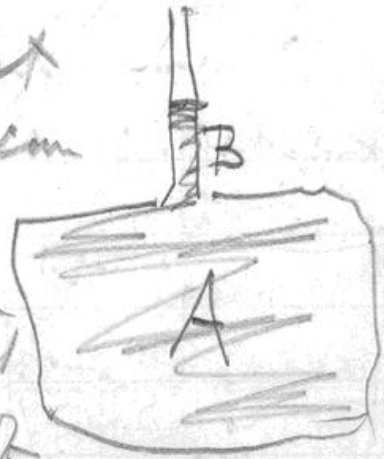
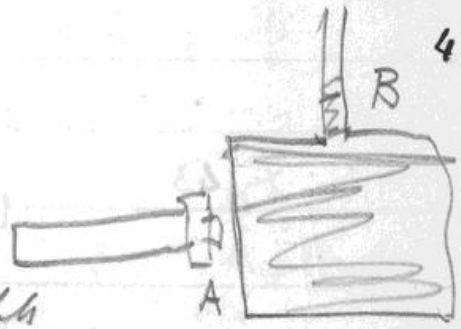


Fig 41

This can be accomplished 1st by using viscid fluid — & 2d by reducing the diameter of

the pipe B — so that the friction of the fluid against the sides of the pipe may retard its motion.

Take latter case



42

When magnetic weakened diaphragm A is released and as liquid is incompressible a considerable amount of (say) water is pushed up pipe B. Now magnet is strengthened A comes towards magnet — but the friction of pipe B delays descent of water and it has not time to run all back before it is again forced up. In this case the vibration of A would give a steady push to a piston in B and operate mechanism as in vibratory circuit breaker.

Similar effect would be produced in viscid fluid without friction pipe.

Probably it will only be a viscid fluid that will expand as whole under influence of sound

59

Adaptation of principle for to multiple telegraphy.

Fig 43

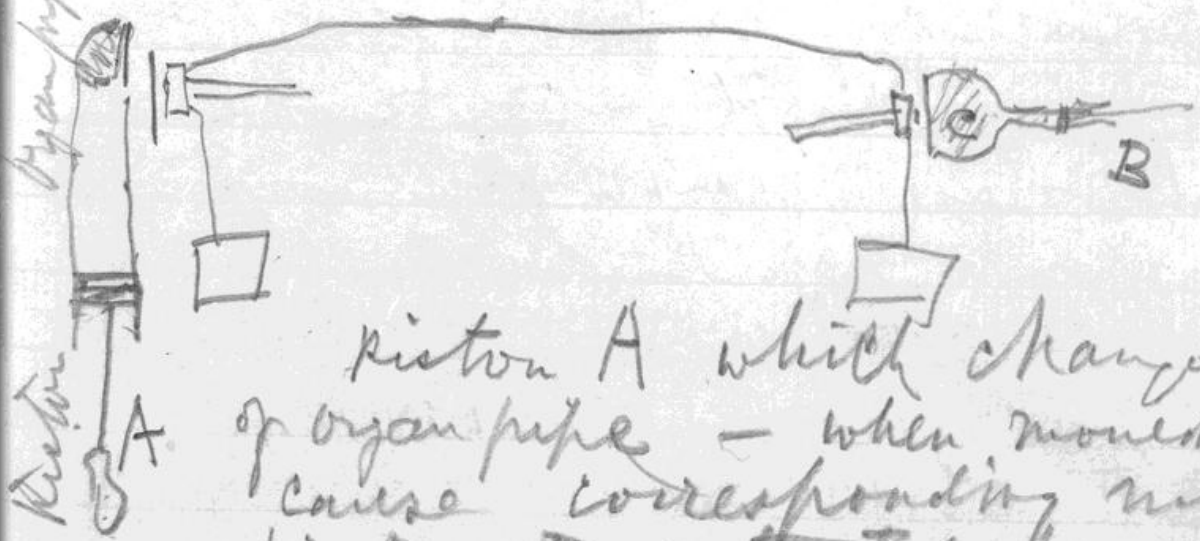
When metal pipe A is above B local circuit is made when reed vibrates — and by putting metal pipe below B circuit could be broken.—

Great defect of vibratory circuit breaker is that it is not operated until reed has attained considerable amplitude. Fluid arrangt would act at once.

If the telephone plate acts upon fluid — ~~Circuit~~ height of liquid is proportional to either ~~height~~ pitch or loudness of sound.

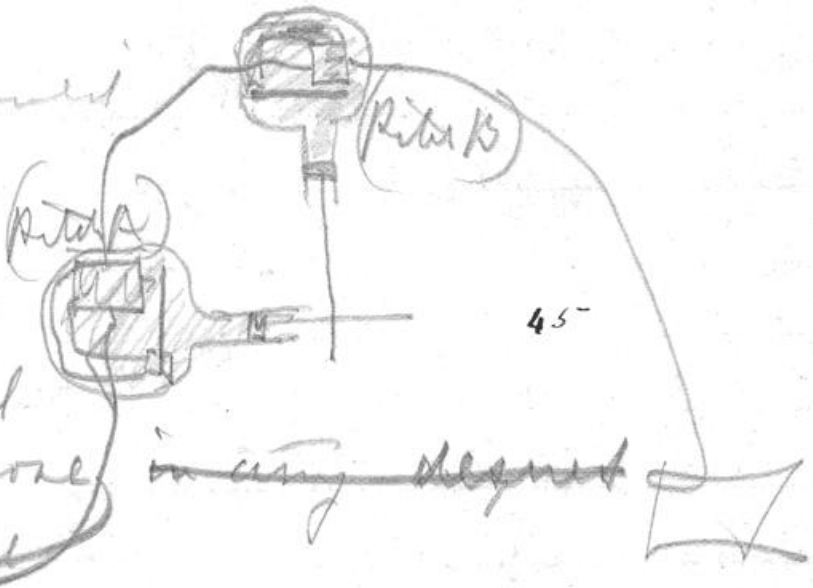
— an entirely new field is opened up — for telephony — Indeed I can conceive it possible that almost any mechanical work can be accomplished at a distance.

~~Suppose pitch to affect~~
Suppose height of liquid to be proportional to pitch of sound then ~~effects~~ following results (Fig 44)



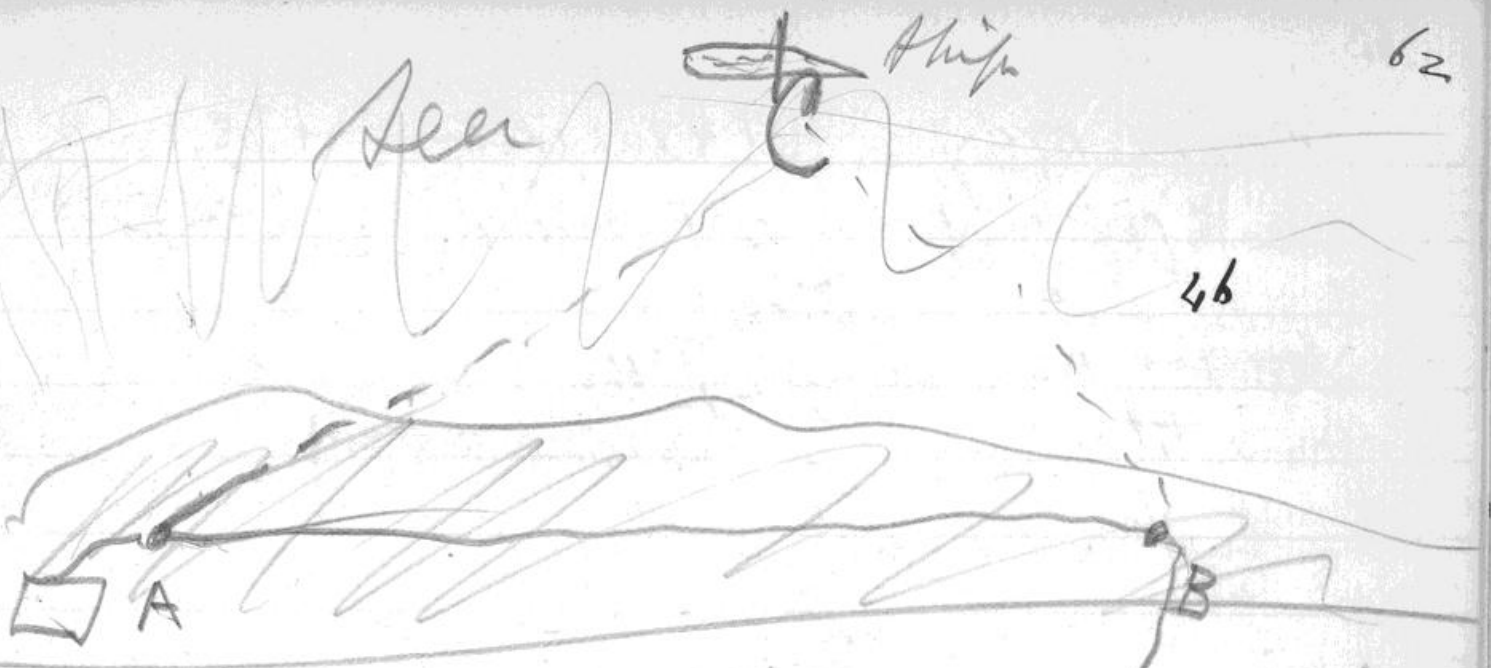
Piston A which changes pitch of organ pipe — when moved will cause corresponding motion of piston B actuated by expansion of fluid C.

of light
If light a varies with amplitude
Then make arrangement like this, at
Receiving end. Pistons worked at right
angles to
one another could
control the
position of a
material point
(say a pencil) and
cause it to move
in any segment
Telegraph line



into any desired spot upon a plane surface
& thus to trace any outline upon that
surface. Or they might be
arranged so as to cause pointers to
indicate upon a map the exact locality
of any distant object the direction
of which is observed by two
separate observers

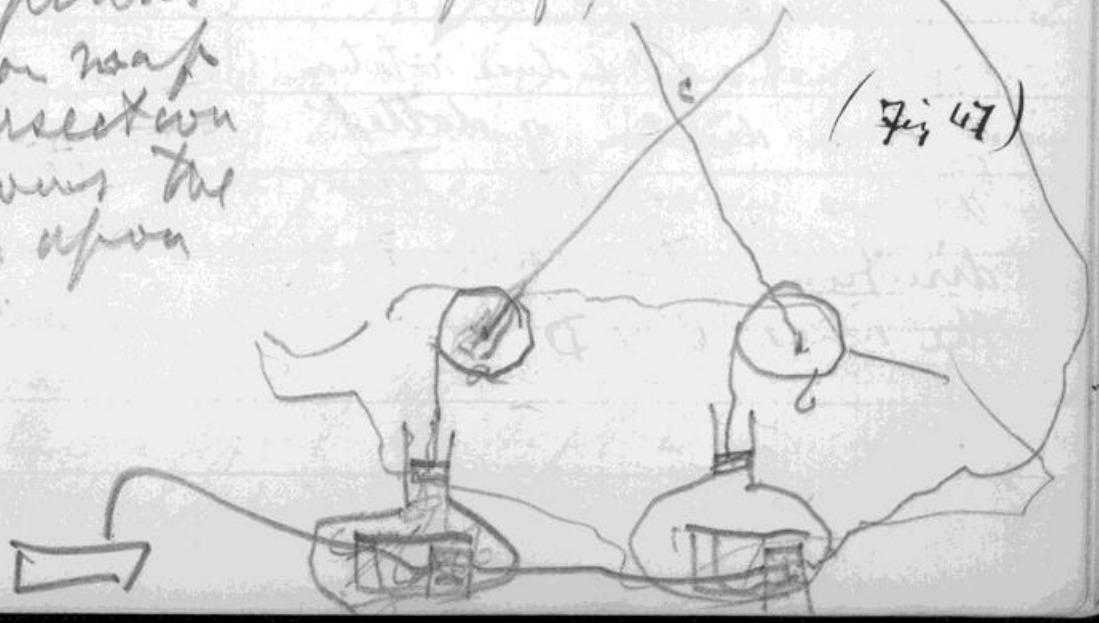
46



Let observers at A & B desire to telegraph to a distant station D the exact place at any moment of the ship on object C. Have automatic apparatus ~~so that~~ at each point & each observer merely keeps the object in view then as angle CAB varies automatic attachments changes the loudness of musical tone at receiving ~~reeds~~ stations ~~records the motion~~ ~~of the ship~~ ~~on the map~~ places on map of place

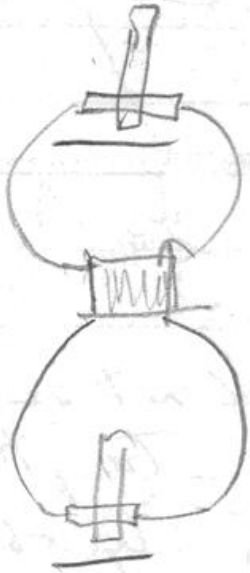
and D.—Two reeds tuned to pitches sent by long rods on map AC, BC, & the intersection of the rods shows the place of the ship upon the map <

(Fig 47)



Dec. 2nd 1877. Chester suggests trying Ruhmkorff Coil & noting whether spark is produced in secondary wires.

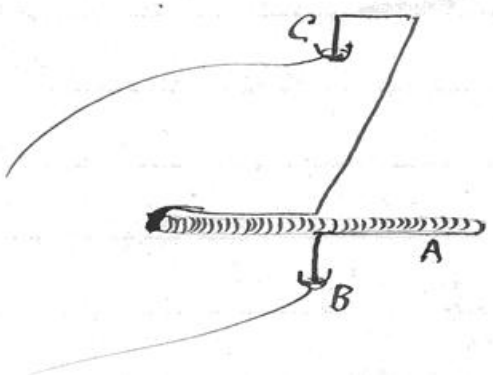
~~When telephones~~



Are phases of vibration of A & B reversed?

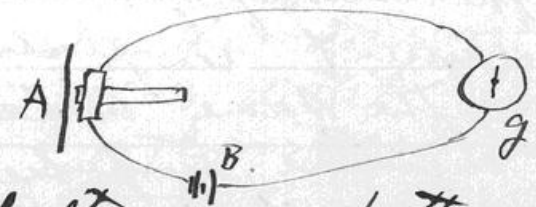
Magnetic needle of galvanometer is deflected to one side when positive current comes and to other side when the current is reversed. If however the magnetism of the needle could be reversed when the current is reversed – the deflection would be to the same side for the positive or negative impulse. Hence needle could be deflected by telephonic current. Instead of needle use a long coil of insulated wire suspended in similar manner. Try also effect of soft iron needle inside coil. Perhaps however that iron will

will not demagnetize sufficiently rapidly. Make following arrangement in place of galvanometer needle.



A Coil of wire
B, C, Mercury connections

N.B. Why should not ordinary galvanometer afford an index of strength of telephonic current indirectly by observing the weakening of a continuous voltaic current when telephonic current is superposed — as in diagram.



Before singing to A let needle of galv. (G) come to rest. The deflection indicates the normal strength of battery (B). Now sound a note in front of A. The result is that rapid alterations of the strength of the current are produced & the galvanometer needle is too sluggish to follow

the changes of intensity. The needle then should settle into a position that would indicate the mean strength of the current. The mean strength of the telephonic current would be indicated by the difference between the mean voltaic current & the mean current.

Let F be the original strength of current & F' the strength indicated when telephonic current is superposed — ~~then~~ ~~F the telephonic current indicated~~ & I mean strength and T the telephonic current.

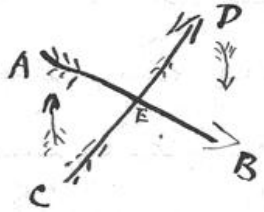
$$T = F - F'$$

Upon second thought this plan won't do. Needle would not move at all. For the positive telephonic impulse would (say) increase the intensity of the current above the normal and the negative impulse would reduce it just the same degree below — so that the mean intensity would be exactly what it was before the sound was made.

Galvanometer idea feasible.

Try following arrangement.

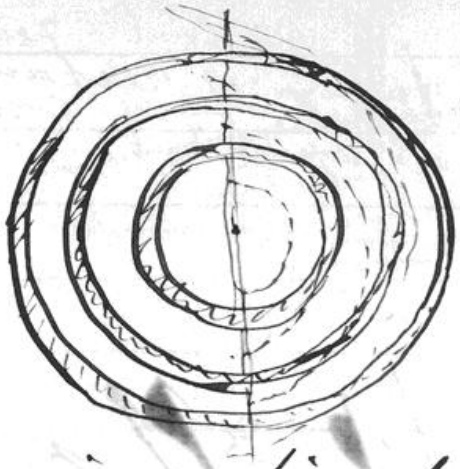
Deflection of needle or of coil-needle — is explained by mutual attraction of currents passing in same direction — so that wires placed at right angles to one another tend to become ~~parallel~~ parallel.



If wire AB is fixed and CD moveable round an axis E. — The wire CD will move in the direction shown by the arrowhead until it is parallel to AB.

Hence if you have concentric rings of wire at right angles to one another as in next diagram and pass currents round the coils the moveable coil will turn upon its axis and tend to come into parallelism with one another. A multiplying arrangement for increasing the effect could be constructed of series of concentric rings. — ~~Let follow~~

That is a series of concentric rings moveable upon a common axis — and another series of



concentric rings fixed at right angles to the first.

Or rectangles within rectangles might prove still more efficient.

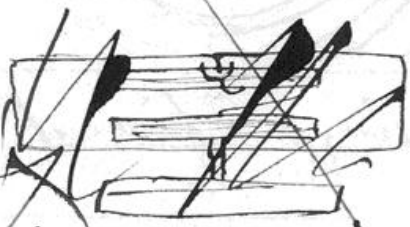
Why should not a flat spiral of wire placed within a rectangle of wire like a galvanometer coil not rotate upon its axis? ~~It would be better to have the~~

Flat spiral

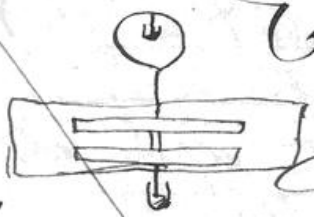
Lower turn of the rectangle would neutralize turning effect of upper turn. No motion would result.

Make rectangle revolve round spiral. Use two spirals reversed so as to act in same direction upon the lower & upper turns of rectangle.

Revolution of rectangle round double flat spirals.

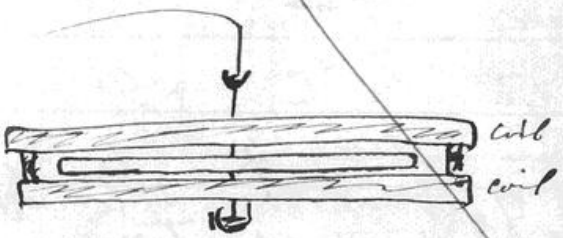


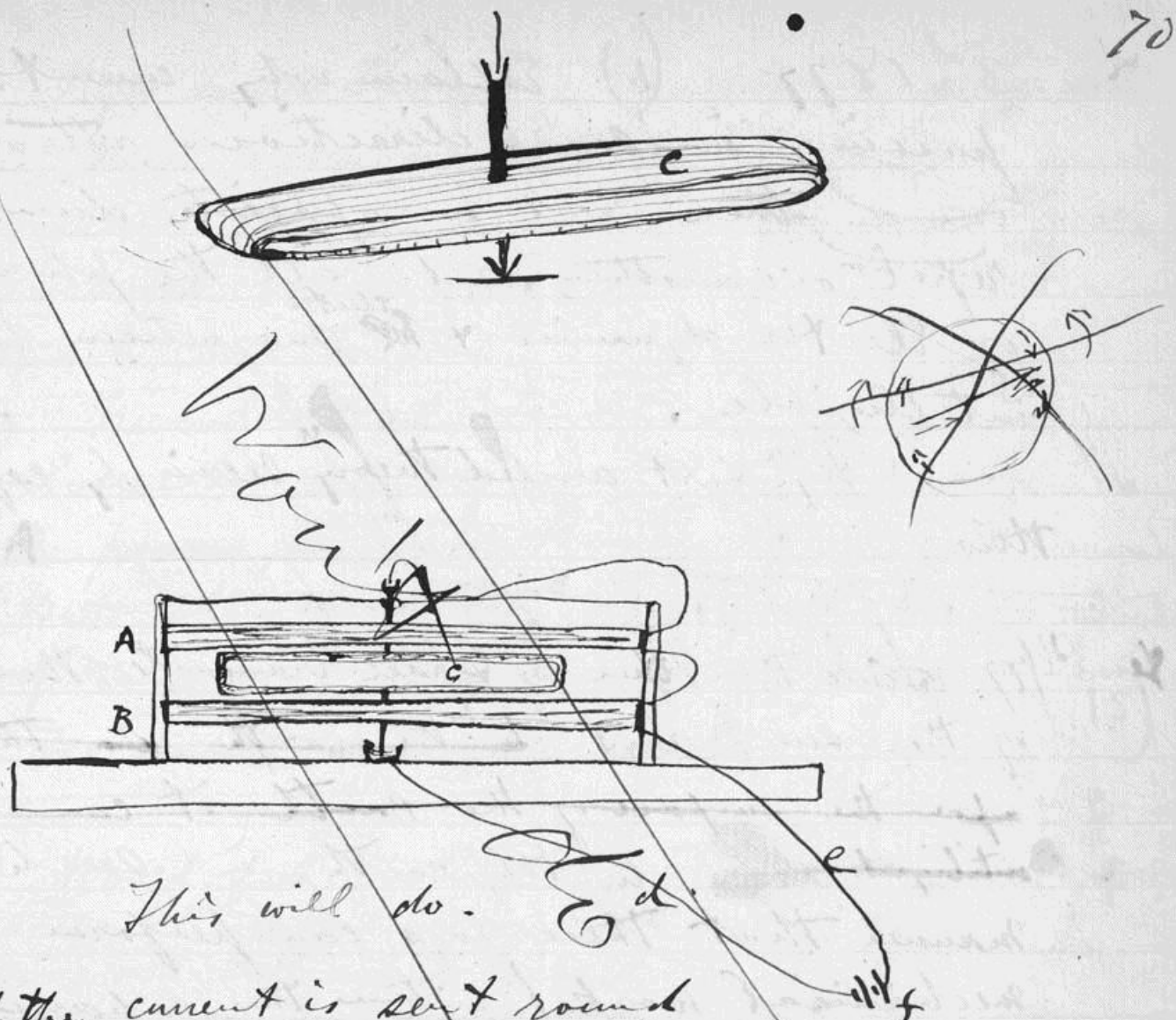
It will be more convenient to make the coils movable & the rectangle fixed. — as in the following. No. The mode of suspension must be peculiar in any case.



Think this out.

Make rectangle revolve within coils.





This will do.

If the current is sent round B in the reverse direction from the current round A — then the rectangle C will revolve upon its axis ~~in a reverse direction~~. when a current traverses the wire d, e, and the direction of the rotation will be the same whichever way the current is passed — Hence place telephone in place of the battery f and the rectangle C will revolve when a sound is made — and the rate of rotation will be proportional to the strength of the current.

Dec. 3d 1877. (1.) Explain why currents passing in same direction attract one another and in opposite directions repel one another and all the phenomena of Electro-dynamics & Electro-Magnetism become intelligible.

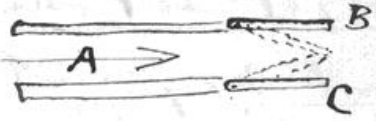
My "right angled theory" seemingly explains this.

Dec. 3d/77 (2) Since the Ether of Space transmits the energy of the sun's rays ~~to the earth so that upon the surface of the earth it can be utilized~~ to the earth in such a manner that these rays can perform mechanical work (witness the expansion of bodies by heat) — it is evident that the ether must be a material substance.

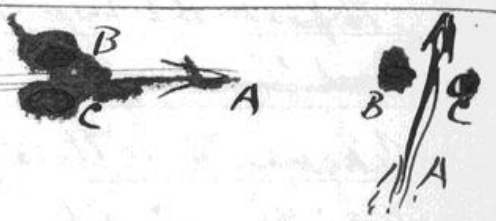
If so it is the only substance in the Universe that is not affected by gravitation. How can this be unless it is itself the cause of gravitation?

(3) "Right angled theory" — explains why it is that when a stream of fluid (A) is passed between two solid bodies (B & C) they tend to come together.

(4) The valves (B & C) tend to close when current of air A passes between them — But when closed they obstruct the passage of the air & they are then blown open. The result is they vibrate



(5) Would free bodies (B & C) supported in a column of air (A) come into collision & vibrate? ~~or revolve around one another~~



6 Would a number of particles (B) placed in a column of air (A) be kept together — come into collision with one another — and vibrate — to and fro in respect to one another — or revolve round one another — keeping however together as a cluster?

7 Would the atoms or molecules of a body behave in a similar manner under the influence of a stream of ether? — and would particles of a uniform size & shape

have definite vibrational periods?

Do the lines of the spectrum indicate the vibrational periods of the ~~molecules~~ atoms of a body? ~~May not a molecule consist of more than two~~ May not a molecular vibration be composite? May it not have a fundamental pitch & overtones? And may not chemical quality correspond to timbre? ~~The multiplication of lines~~

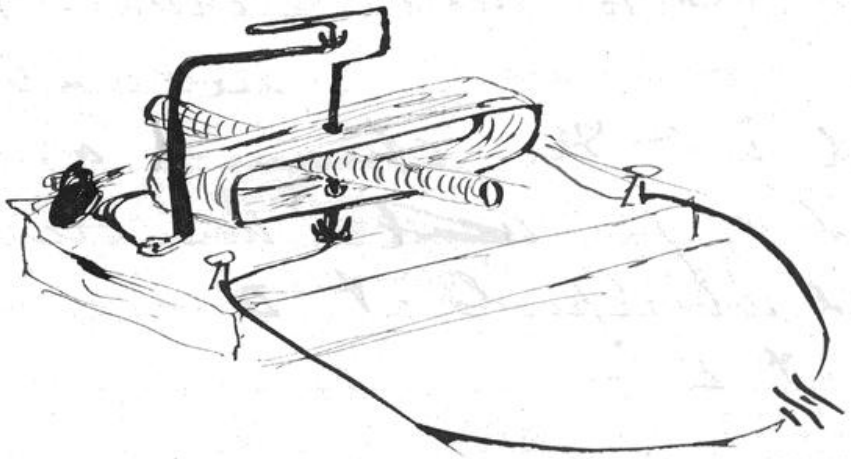
Have Most of the so-called elementary substances are characterized by more than one line. ~~The number of lines~~

The multitude of lines in the spectrum of iron — seems to indicate that it is particularly opaque to ether vibrations. Perhaps this opacity might explain its magnetic properties. Is there any marked difference between the spectra of magnetic & dia-magnetic bodies? Is the spectrum of a magnetic body characterized by a multitude of lines?

If so it is probable that a current of ether playing upon such bodies would tend to ~~push~~ carry the body with it — whereas other bodies might permit the flow of ~~matter~~ ether through its molecules without being dragged along as a whole by the current.

(8.) An experiment quoted in Ganot's Physics (page 737 foot of page) seems to indicate that a conductor is elongated during the passage of a current. Doubtless a molecular vibration is produced by an intermittent current.

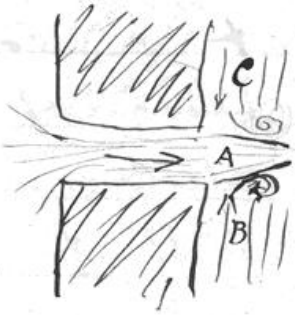
(9)



The solenoid will be deflected like a galvanometer needle but it will be deflected to the same side by currents of different polarity. Hence it should be deflected by current from the Telephone.

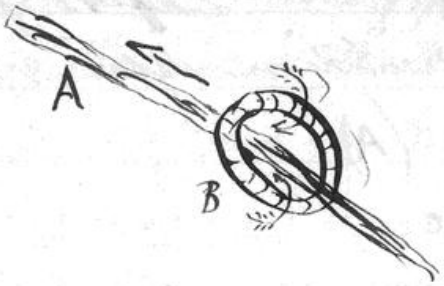
Dec. 6th 1877. Fluid in motion exerts no pressure at right angles to its course.

Sluice stream of water at Salem Mass in flowing into pond at A was unable to resist compressing effect of water at rest at B & C.

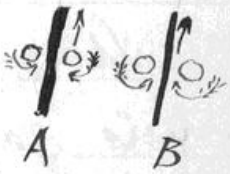


Weeds & floating objects at B & C indicated that the water moved towards the stream A as shown by the arrow heads. The water from B & C. pressed into the stream A and were then carried off ~~at~~ thus occasioning right-handed whirlpools at D and left-handed whirl-pools at E.

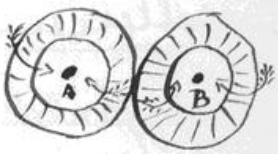
Apply this to a stream of air ~~which~~ We have the explanation of a vortex-ring. Indeed theory shows that every stream of fluid ~~is~~ must be surrounded by a vortex ring. The ring



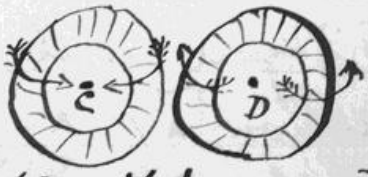
Every stream of fluid A should be accompanied by a vortex-ring ~~at right~~ the plane of which will be at right angles to the direction of its motion.



Let there be two parallel currents A & B ~~going~~ going in same direction. Consider effect of vortex-rings upon one another. Can an explanation be afforded of attraction & repulsion of electrical currents by supposing ether-vortices round wires.

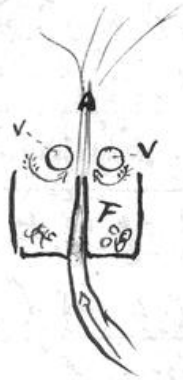


If C & D directions of the currents are opposed.

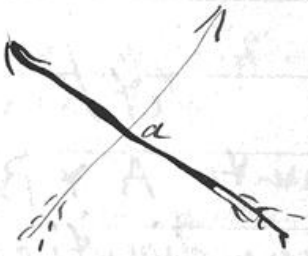


In case of A & B ~~vortex particles~~ vortices would be moving in the same direction and would coalesce (?) while in C & D the ~~vortex particles~~ vortices going in opposite directions strike against one another and throw each other off — that is repel one another (?). Does expectancy lead me to jump to a conclusion or is this a vera causa.

If theory is correct following experiment would demonstrate the formation of a vortex-ring. Blow stream of air (A) from nozzle of pipe. Let the chamber (F) be filled with fumes of some kind. Then ~~a~~ stationary vortex ring would make its appearance at V.

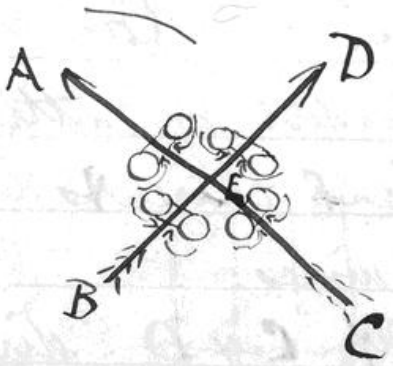


Angular currents. Will vortices explain rotation upon axis ~~of~~ and resultant parallelism of ~~flow~~ currents.



Yes. ~~Yes~~

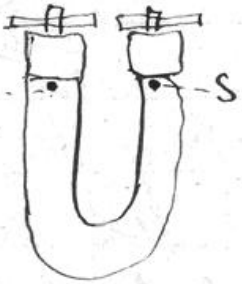
∠ AED vortices coalesce
∠ DEC " repel
∠ CEB " coalesce
∠ BEA " repel



Hence currents ~~AC~~ CA & BD if free to move will rotate upon their point of intersection as an axis until they are parallel & flowing in the same direction.

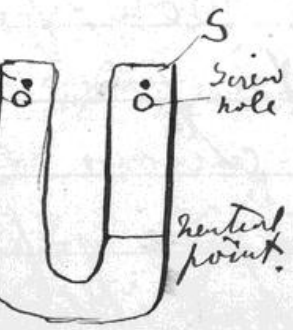
Dec. 5th 1877. Bought a compass needle and tested magnetism of large compound magnet telephone. The large telephones with which I illustrated my lectures in America are now feeble and I have been unable to produce good effects with them. The poles seem to have shifted back. The needle indicated maximum points of magnetisation as in diagram at N & S.

Fig 1



I took instrument to pieces and tested each magnet separately to determine the localities of the poles and of the neutral points. In all the neutral point was upon one side instead of at the bottom as in diag 2. Blue blend — & with one exception the magnets were too weak to support their own weight.

Fig 2



Experimented with reduced iron to test whether metallic copper could be deposited

upon writing made with an ink composed of reduced iron mechanically suspended in a liquid. I remember that in former experiments copper was immediately deposited upon the blade of a knife when dipped into solution of Sulphate of copper. I hoped that copper would be deposited from the solution upon the iron-writing.

No result — But am not discouraged for I could obtain no deposit upon the blade of a knife dipped in solution. Cannot remember the circumstances of former experiment — excepting the fact of the instantaneous deposit of copper upon iron or steel dipped into solution. I find that the reduced iron can be used in place of iron-filings in showing the lines of magnetic force about a magnet. A very curious effect was produced by covering a piece of paper with a layer of reduced iron about 1/40 of an inch in depth — and then bringing down the paper towards the magnet.

Before placing the paper on magnet

the appearance was as if it were covered with a layer of black garden mould.

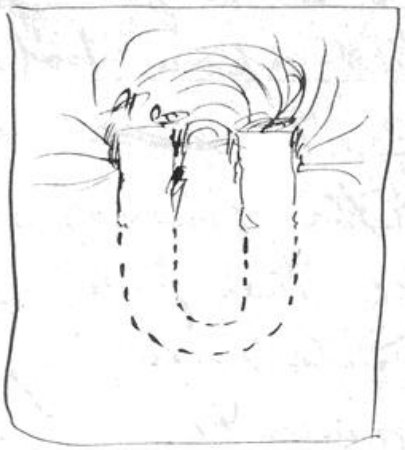
But upon holding the paper over the magnet ~~and~~ about three inches away the layer of iron appeared ~~like~~ glossy like the fur of a mouse — due to the particles arranging themselves in parallel filaments. On account of the extreme smallness of the particles and consequent thinness of the filaments it was only by close inspection that the filamentary arrangement of the particles could be seen — the effect at a little distance being merely that the plate moved acquired a glossy silky appearance (like smooth fur). Upon moving the paper downwards — the fibres over the magnet became erect and each fibre repelled its neighbour so that ~~at Record~~ a picture of the magnet was produced.

The effect was really very curious and quite different from that produced by powdering iron filings upon a sheet of paper over a magnet — or by tapping the paper.

The effect produced by tapping paper ~~with iron filings~~

is shown in Fig 3.

Fig 3



The effect produced when thick layer of reduced iron is used is shown in fig 4.

In both diagrams portion of the magnet is indicated by dotted lines where not shown

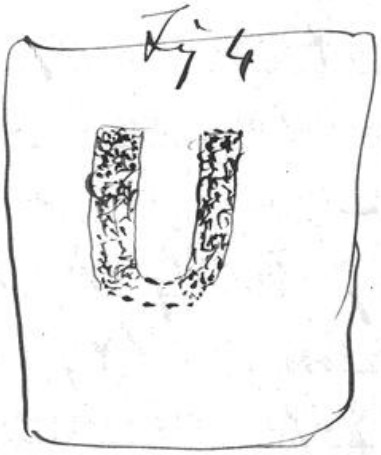


Fig 4

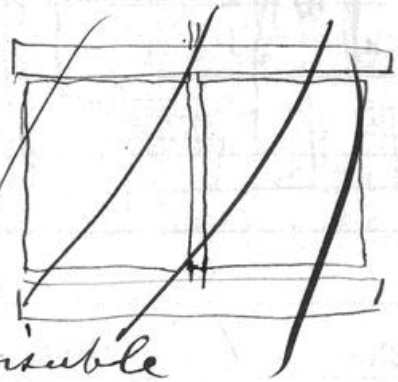
The portion of the magnet not indicated by the arrangement of iron particles is shown in dotted lines.

In fig 3 the particles collect over the edges of the poles and upon curved lines uniting the poles. In Fig 4 they stood erect over every portion of the magnet excepting the end.

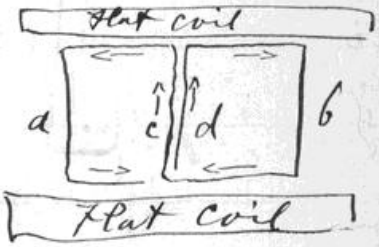
~~There was a curious feeling of seeing through the paper~~

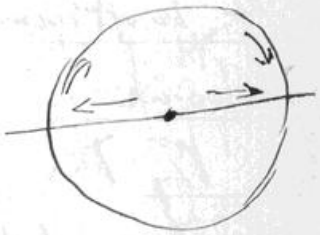
Would rectangular arrangement of current shown in Fig 5 placed between flat coils of wire produce rotation.

5



Vertical portions a × b would tend to retard the rotation. Hence it would be advisable to have rectangle longer than coils as in fig 6.





6

Vertical ~~portions~~ currents c, d, (Fig 5, 6,) assist rotation. Make apparatus as shown in Figs 7, 8, 9, 10.

Fig 6

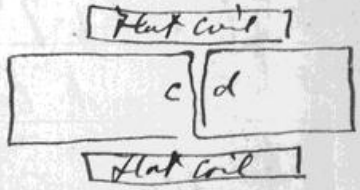


Fig 8
Flat ring-coil

Fig 9
Vert. sec. of flat ring coil + rotator.

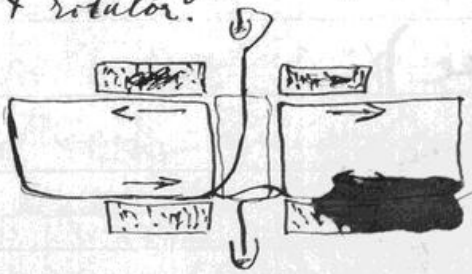


Fig 7

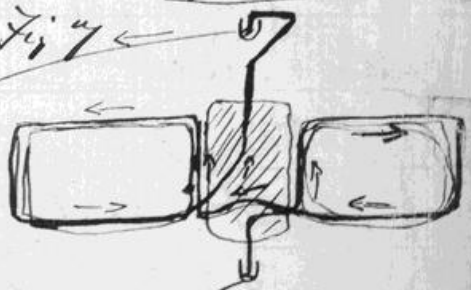
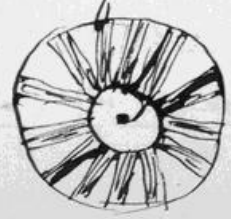
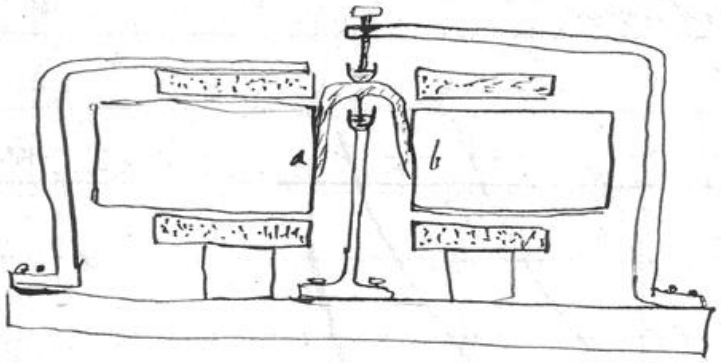


Fig 10
Plan view of rotator



Upper mercury cup wants modification as ~~it would~~ its support would ~~from~~ stop rotator. (Fig over)

Rotator with mercury support as follows.



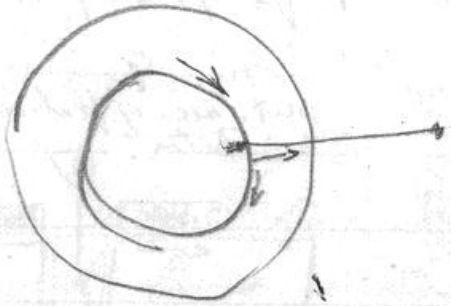
If instruments succeed in measuring current from Telephone – call them "Electro-phonometers".

By the bye why should not the "Electro-phone" be a distinctive name for the Speaking Telephone.

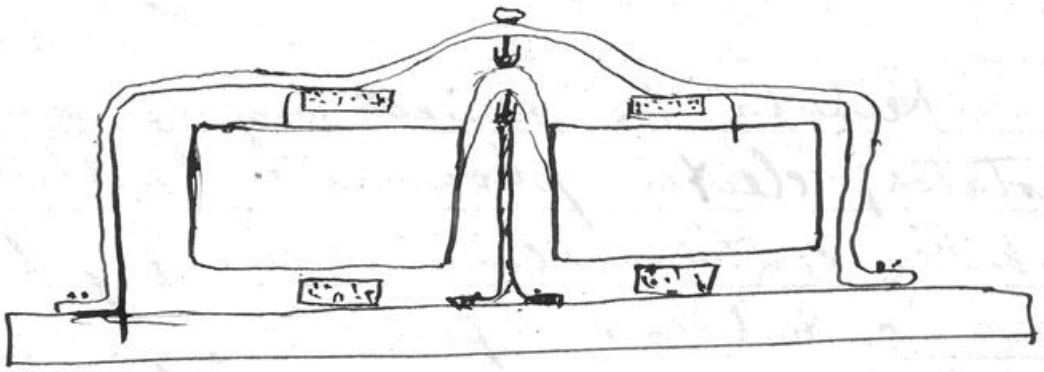
Dec. 6th. 1877.

Upward current at a b (see fig above) tends to oppose rotation.

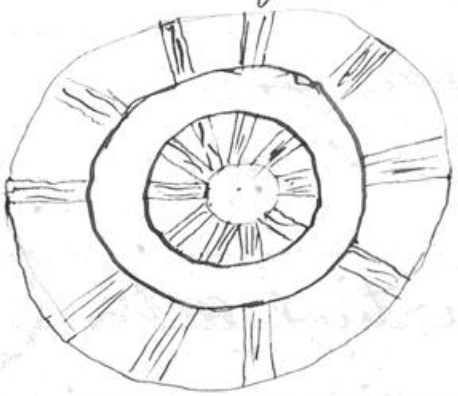
In fact all the vertical currents oppose rotation. Hence employ a horizontal flat ring of wire as in next diagram



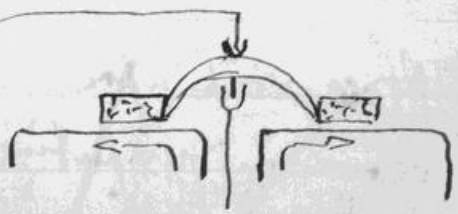
Sectional elevation of
Electro-phonometer



Plan of same



Since the rectangular arrangement is no
much larger than the improved coil — it may
be better to make the rectangular part fixed x
the flat ring movable —
As in diagram.



Patent in Germany applies for Aug. 26th 1877.

Dec. 6th. Perhaps the easiest way of making the rotatory electro-phronometic will be

(1) to make (1) a continuous coil as in fig 1.

(2) (2) Remove central core upon which it was wound. (Fig 1)

(3.) Tie one side tightly together as in fig 2.

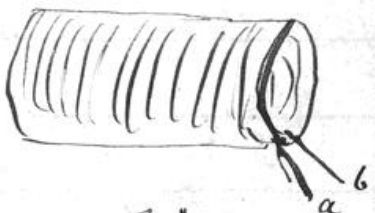


Fig 2

(4) Open it like a fan so as to make an orange shaped coil as in Fig 3.

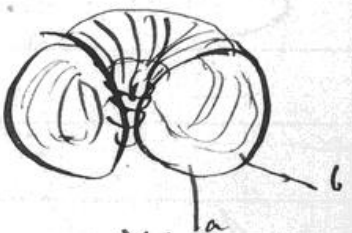
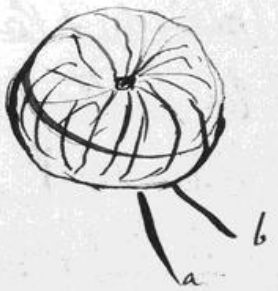


Fig 3

(5) Fig 4. is ~~section~~ vertical section of same.

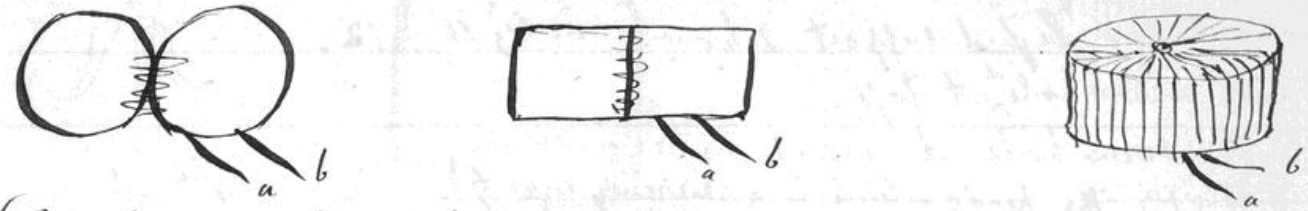
(6) Flatten it down as in Fig 5.



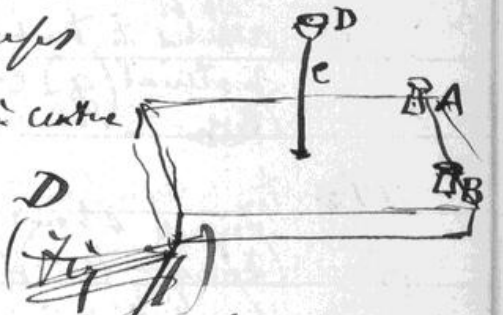
(7) Perspective view of arrangement see Fig (6)

(8) Place coil upon wooden base as shown in perspective in Fig 7 and in vertical section in Fig 8. With th

Fig 4 Fig 5 Fig 6



(8) Prepare base board with two screw cups A & B and a tall metallic rod C in centre bearing upon its summit a mercury cup D (see Fig 7.



(9) Place coil upon board as in Fig 8. (Fig 8) The two ends of the coil to

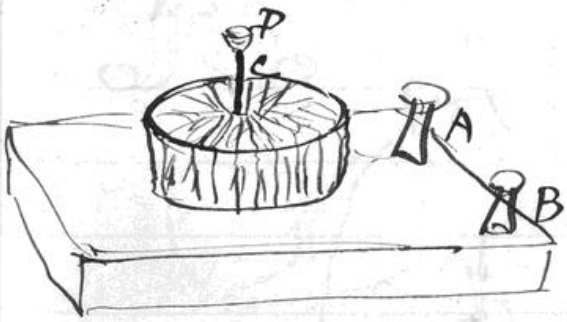
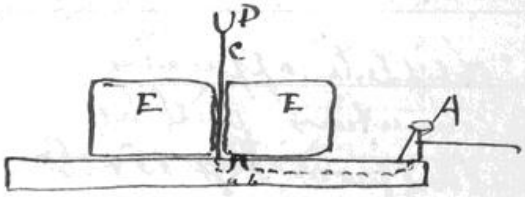


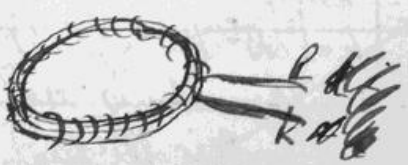
Fig 9



be connected one with screw cup A and the other with metallic rod C as shown in Fig 9 in which E is the coil.

(10) Make a thin ~~coil~~ ring of the finest wire possible so as to be very light. Let diameter of ring be one half the diameter of the coil shown in fig 6. Tie the ring round with thread or string so as to make it as solid as possible. See Fig 10.

Fig 10



87

11. Construct of ~~some light material (wood)~~ aluminium the three legged support shown in Fig 11 & 12. with screw hole d at top. (Fig 11)

12. Into screw hole d insert metallic screw (e) Fig 13 the head of which is a mercury cup (f). attached to the base of the screw is an insulating material (g) carrying a platinum wire (h).

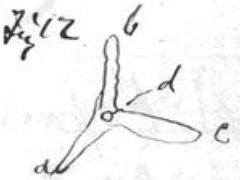
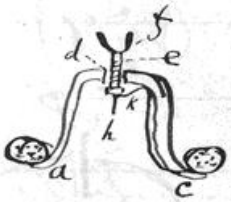


Fig 13

13. Fig 14 shows sectional view of tripod support carrying the flat ring (shown in perspective in Fig 10).

One of the terminals of the ring is attached to one of the legs (a) and is thus connected with the mercury in (f). The other terminal (K) is attached to the platinum wire (h).

Fig 14



14. The complete apparatus and connections will be understood from Figs 15 & 16 The whole instrument is placed under a glass shade. A piece of paper is pasted on the upper side of the coil and an arrow-head drawn upon it. The number of times this arrow-head passes the upright (m) indicates the number of rotations. Of course the paper can be divided off into degrees for convenience of reading.

(Fig 15)

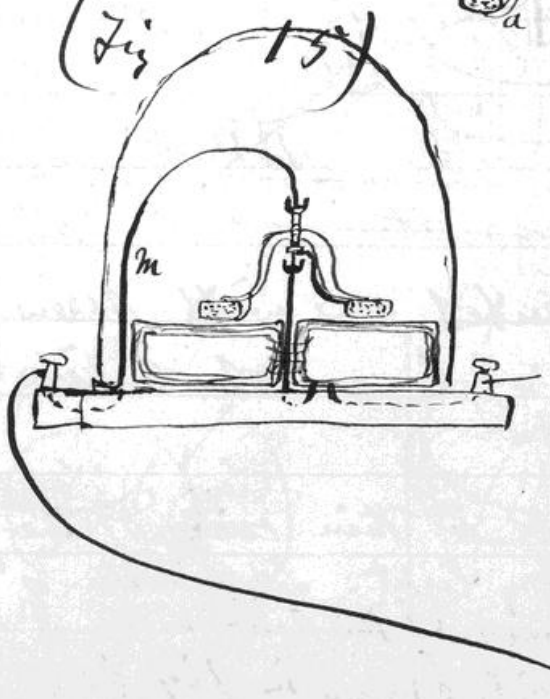
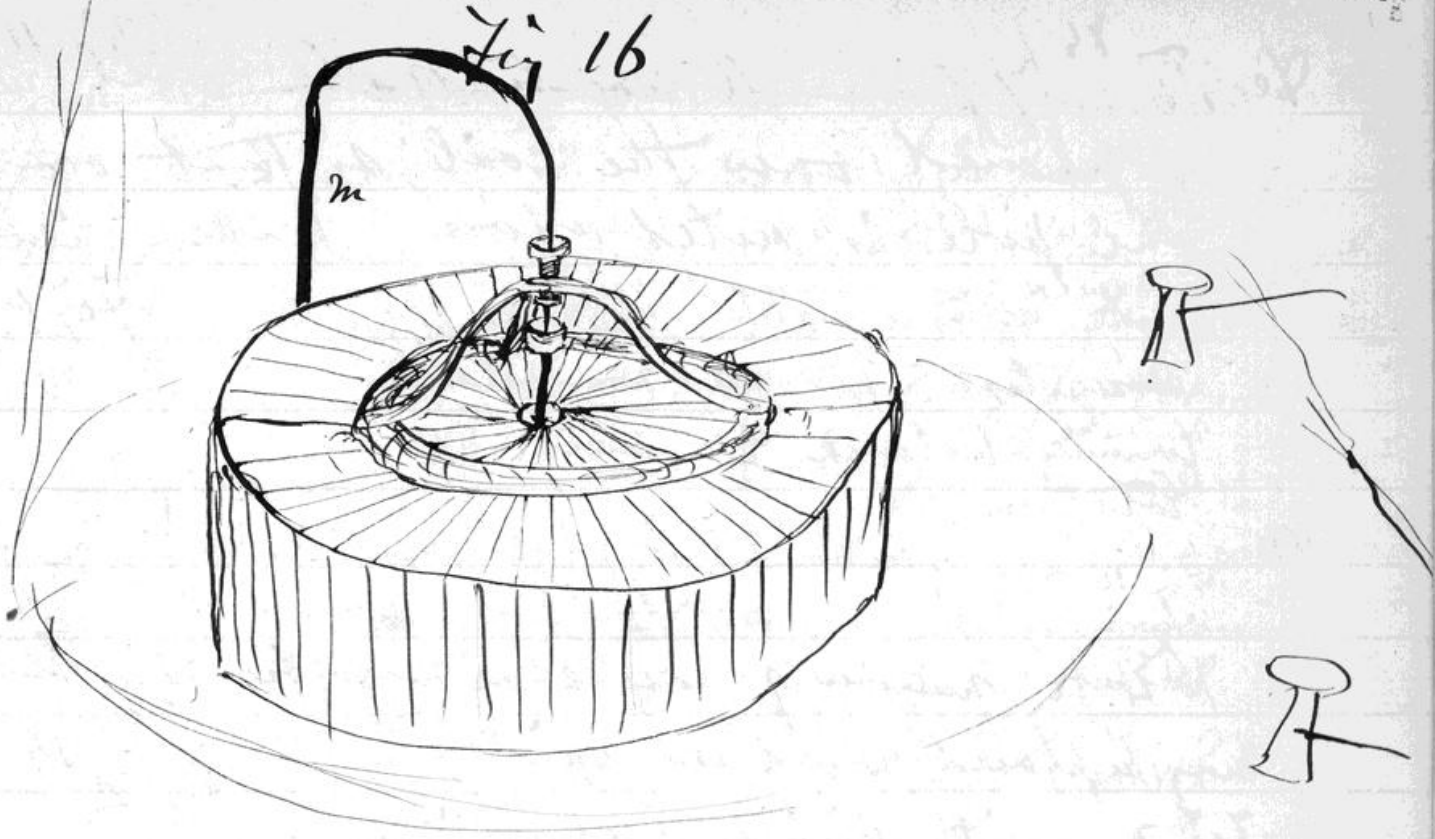
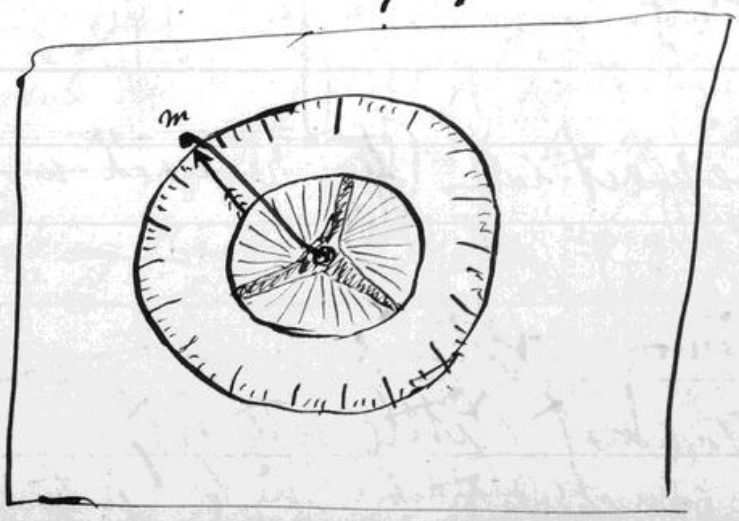


Fig 16



The Electro - phonometer.

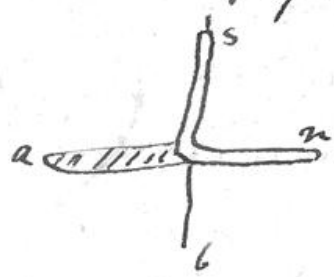
Plan of card attached to Phonometer. Fig 17.



Dec. 8th/77 A magnetic needle will revolve if placed over the coil so that only one pole is acted upon. Make needle bent into a right angle.

Two poles S. N. a non-metallic counter-balance as axis of rotation.

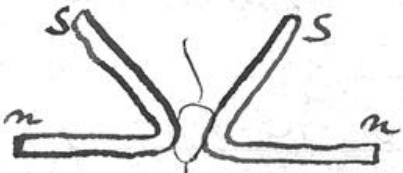
Fig 1



Or a number of horse-shoe magnetic needles may be placed round an axis as in Fig 2. with similar poles horizontal.

This will admit of delicate suspension.

Fig 2



Of course a rotation in one uniform direction can be obtained by replacing needles by solenoids.

Flat coil of wire much better than needles.

Important

Calculate effect of the reversed undulatory current of high intensity but little quantity —— superposed upon continuous voltaic current which possess great quantity but little intensity.

Can a current of high intensity but little

quantity neutralize a current of great quantity but little intensity? This is important — for if it can — then induction can control the strength of a battery current the loudness of the sound; and ~~the voice~~ at the receiving end will be proportional to the strength of the battery.

What is the effect of permanent magnet vibrated in front of electro-magnet in circuit with a battery? Can quantity as well as intensity be graphically illustrated?

Important — think this out.

Perhaps best way of doing so will be to take simile of river and find a graphical method of representing velocity of flow and quantity of flow.

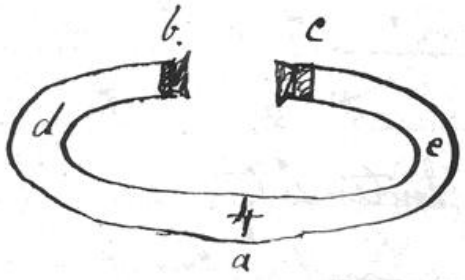
Superpose current A upon current B. Let them be of opposite kinds. Will A neutralize B if B has twice the quantity of A and only half its intensity?

Taking the simile of the river it seems as if Quantity & Intensity should be inversely proportional to one another. For take two pipes A & B of different diameters. The amount of water passing through A will equal that through B if B has half the diameter of A & the water passing through B has double the velocity of that passing through A

To pursue the analogy between dynamical electricity and a current of fluid still further.

Let us consider dynamical electricity as simply a current of ether flowing along ~~a conductor~~ or through a conductor as a pipe.

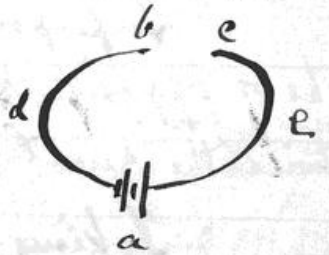
Fig I



Let (a) be a screw or turbine wheel rotated in the pipe and let the ends b & c of the pipe be plugged.

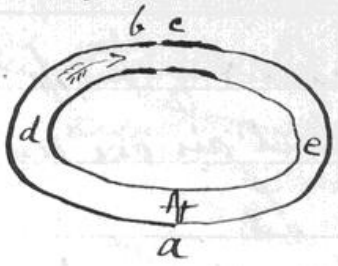
The rotation of a will occasion a condensation of air in one branch (d) and a rarefaction in the other ~~pole~~ branch (e) or vice versa — the difference of density in the two branches (d & e) being proportional to the velocity of the rotation of (a).

(Fig 2)



Follow out analogy with battery (a) Fig 2. Suppose the chemical action of battery to ~~deposit~~ transfer ether from one pole to the other and to cause an ether condensation in the terminal wires d & e. A statical effect would be produced & (b) & (c) would be ~~charged~~ charged oppositely.

Fig 3



Referring again to Fig I.
Remove the plugs from b & c and join the pipes as shown in Fig 3.

The rotation of (a) then produces a current of air in the pipe flowing from the condensed part (d) to the rarefied part (e).

The air in branch (d) is constantly of greater density than that in branch (e) so long as (a) rotates and a current of uniform velocity flows from (d) to (e).

Fig 4

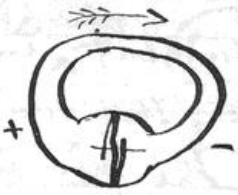
So when terminal wires (b,c) Fig 2 are united as in Fig 4 a current of ether flows from (d) to (e).

(d) & (e) have constantly different potentials so long as chemical action of battery lasts — ~~and the intensity of the current depends upon the~~ and a current of ~~different~~ uniform intensity passes from (d) to (e)

Analogy between electrical phenomena

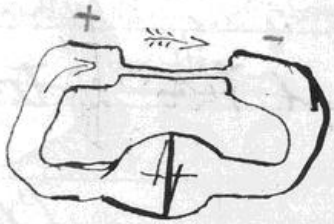
1. No current of air. Statical effect.
Condensed air one side rarefied air other side!

2. Current of air produced.
Condensed air on one side rarefied air on other - and motion attempting to restore equilibrium.



3. Current of air produced.
Free communication with outside air.
Air in one arm denser than outside ~~air~~
Air in the other arm rarer.
Current passes to restore equilibrium.

4. No current of air. Statical effect.
Air in one branch same density as outside air. Air in other branch rarefied.



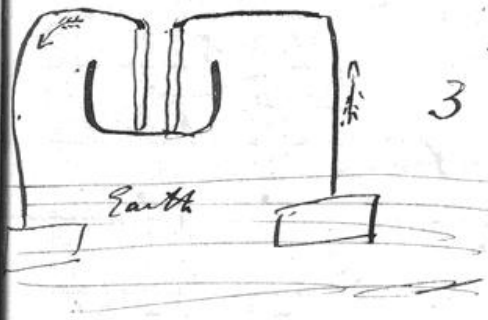
5. Current of air. Same quantity of air passes each cross-section of pipe in same time — but the velocity with which air moves greater in the narrow pipe.

1

1. No current of electricity. Statical effect; Positive charge one side. Negative charge other side.

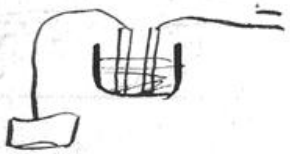
2

2. Current of electricity produced. Potentials different on the two sides — positive charge on one side negative on other — and current of electricity seeking to restore equilibrium.



3

3. Current of electricity produced. Free communication with outside electricity contained in the earth. Potential ~~greater~~ in one ~~one~~ terminal greater than earth's potential — in other terminal less. Current to restore equilibrium.

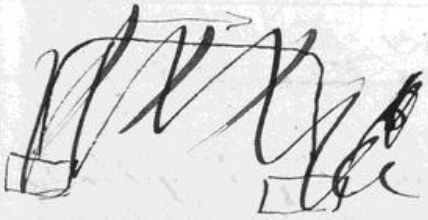


4

4. No current of electricity. Potential of one terminal same as earth's potential Potential of other — less. (?) (Is this so?)

5

5. Current of electricity. Same amount of electricity passes each cross-section of wire in same time — but intensity of current greater in thin wire. (?) (Witness heating of platinum wire. &c.)



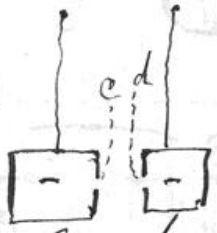
Analogies between ~~the~~ the phenomena

Dec. 9th. 1874.

To pursue investigation shown on preceding page — Seek to find analogies for the phenomena of ~~electricity~~ electro-statics

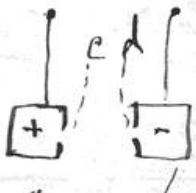
1. Suspend boxes or balls a, b, filled with compressed air. When apertures c x d are opened so that the two ~~bodies~~ portions of condensed air may act upon one another — ~~the~~ air ~~from a x b rushes out~~ from the cavities (a x b) rushes out and the two bodies are pushed apart.

1



2

Conceive the action of two portions of compressed air ~~on~~ upon one another without being enclosed in ~~an~~ an envelope. The two condensed ~~bodies~~ bodies (a x b) expand and push each other apart.



3

2. The analogy here is uncertain. Take two boxes a x b. ~~from which Exhaust~~ Produce a partial vacuum within them. Suspend them as shown in diagram. Open the apertures c x d — What will happen? The outside air will rush into the two cavities — but will the boxes a x b be pushed apart by the air that rushes in between them attempting to push its way into the cavities? It may be so. Experiment will show. Cannot however see any reason why they should not rather come together — ~~in~~ in which case the analogy ceases. Imagine the envelopes ~~removed~~ removed of (a x b) to disappear would ~~the confined air~~ a x b approach or recede from one another — or what would happen? Would they merely stand still & be condensed?

(over next page)

g ~~Statical~~ Electrostatics and Hydrostatics

Statical Electricity

1 Two ~~bodies~~ bodies similarly electrified
2 repel one another.

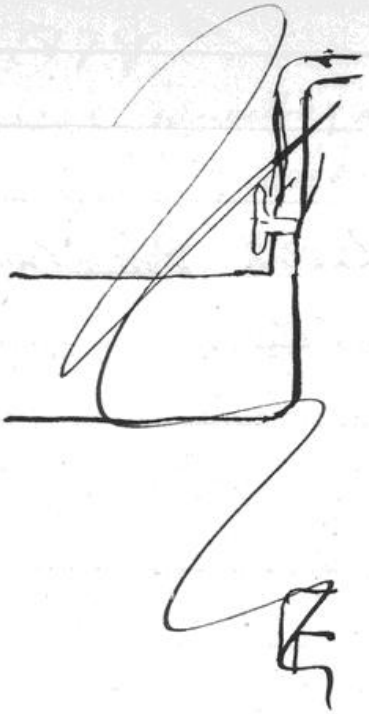
2 ——————————

3 3. Bodies oppositely electrified attract one another.

---

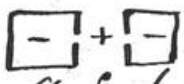
3. In this case the analogy is complete. (a) is filled with condensed air & (b) with rarefied air. When the apertures c d are opened — the two boxes will rush together.

Apparatus can be simply constructed for testing the idea. See over page.



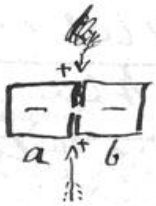
It seems to me from consideration of case 3 page 95 that in Case 2 a vibration of the bodies would result.

1. First consider them as apart.

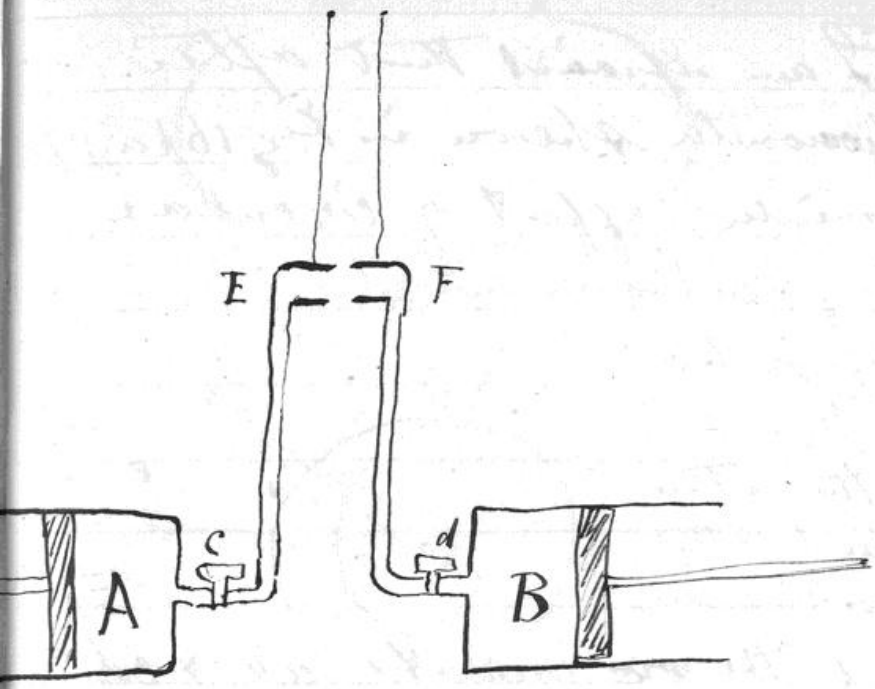


The air (c) between (a + b) is relatively condensed. There will then be an attraction between (a+c) and between (b+c) Hence (a + b) will approach one another.

2. Next consider them in contact.



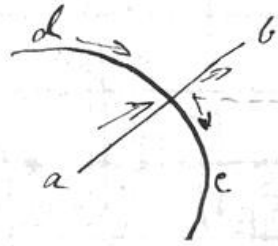
The air outside being denser than the air inside (a + b) tends to pass its way in between (a+b) as shown by the arrow heads hence the boxes a + b should be forced apart. When they have receded from one another — again should they approach and then it may be that a vibration should be produced.



By the motion of the pistons the air in cavities A or B can be expanded or contracted and upon opening stop-cocks c & d the motion of the boxes E & F can be observed.

Nov. 9th. 1877. I am afraid that after all the Electro-phoromotor shown in Fig 16 page 88 will not rotate: for consider effect of circular current crossing rectilineal current.

a & d attract — but so do b c —



why therefore should not the one attraction neutralise the other at the point e. Indeed the point e would have a tendency to remain fixed — and the currents ab, & cd, would tend to turne upon e as an axis until they became parallel.

It is a question however what the effect of the fixity of the rectilineal current (ab) and of the curve of the circular current might produce. Since ab is fixed d c has the tendency to assume the position d' c'. Fig 1 page 100.

No. Rotation would not take place. It might however succeed if a flat coil were used extending all the way from the centre to circumference — for the ascending currents at the centre would neutralize ~~those at the circumference~~ the descending

Fig 2

Fig 1.

currents at the circumference.

~~Yes~~ No. Currents at circumference have advantage of leverage.

Try arrangement in fig 4. descending current so close to ascending current that they neutralize each others action upon the flat coil a – so that the horizontal current (b) may be considered as acting alone In fact effect would be equivalent to fig 5.

Why not zig-zag the wire as in fig 6? No advantage over straight wire.

What effect would small circular current have on segment of large circ. current as in fig 7? Represent attraction by (+) and repulsion by (–).

No movement would result.

Fig 3

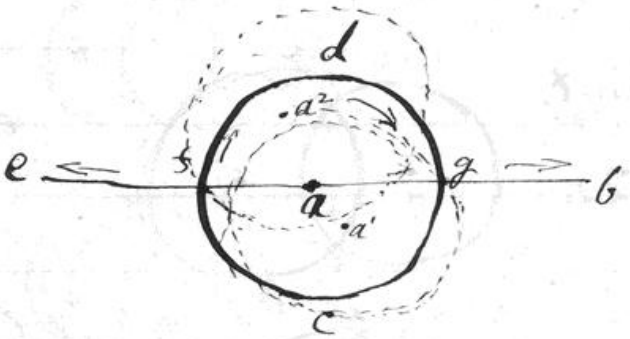


Fig 4

Fig 5.

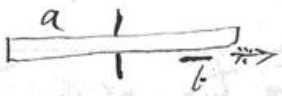


Fig 6

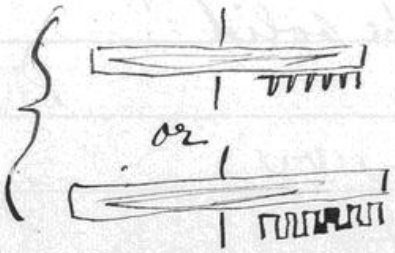
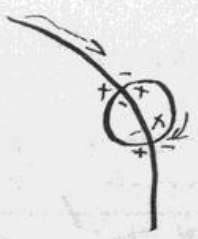
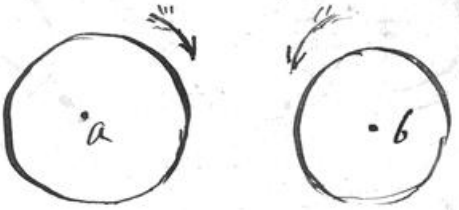


Fig 7.



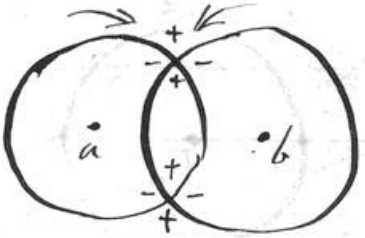
What effect will two circular currents have upon one another when they are not concentric.

1. a & b simply tend to approach one another when currents flow in same direction & repel when in opposite direct. No tendency to rotation.



1.

2. They would approach until their rims are in contact - but would then be in unstable equilibrium. They would move to one side or the other their planes forming an obtuse angle. This angle would then become less & less until the planes were parallel...

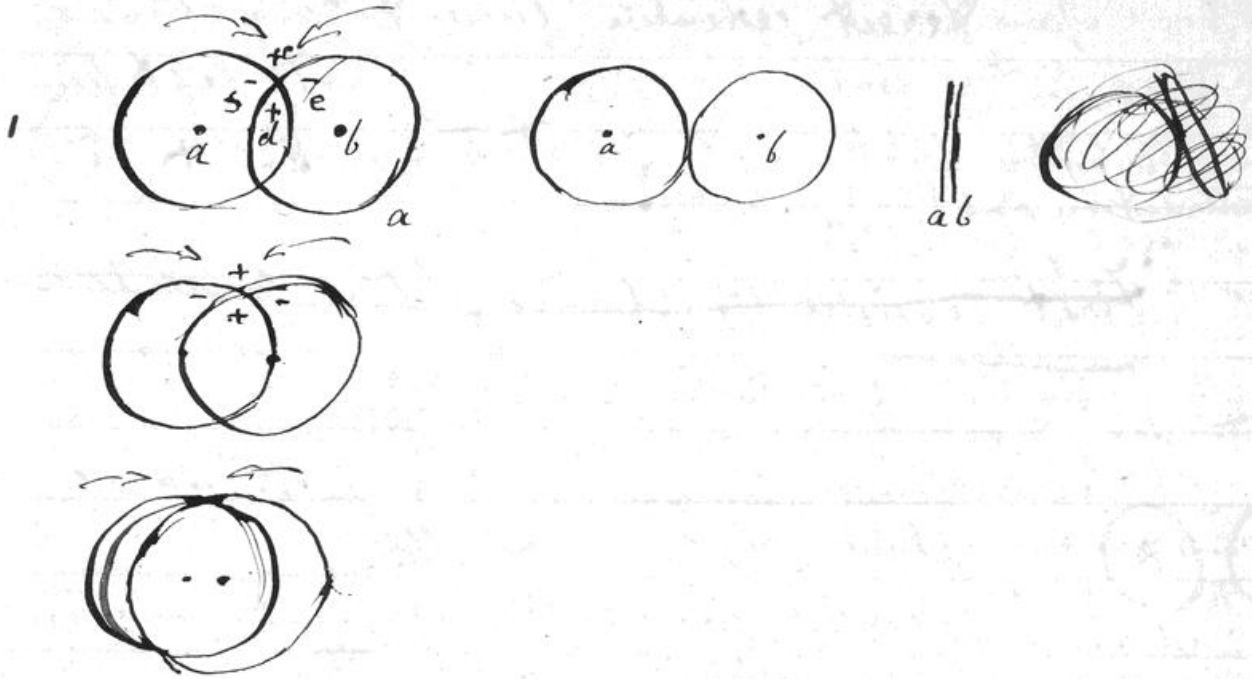


2.

3.

2. The circular currents a & b tend to turn upon their points of intersection as an axis ~~so that~~ until their planes are parallel. Let their planes be solid

Circular currents intersecting one another.



Circular currents intersecting one another.

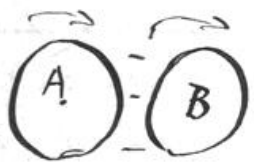
"Direct" circular currents call those in which

Over

Effects of circular currents upon one another.

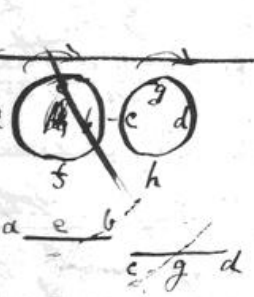
Direct circular currents are those which turn in the same direction — both left handed rotations or both right handed rotations. Use (+) to mean attraction and (−) repulsion

~~Direct consider the planes of the currents as parallel.~~

1. 

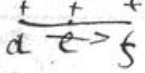
Direct circular currents in the same plane repel one another

Reversed circular currents in the same plane attract one another.

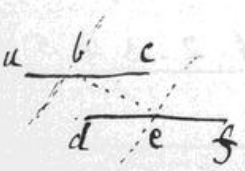
2. 

~~repel one another~~

Direct circular currents in parallel planes ~~attract~~ tend to come together so as to be concen

2 

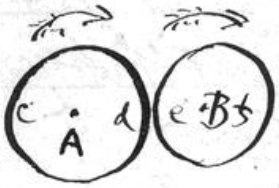
Direct circular currents in parallel planes attract one another when the line joining their centres is at right angles to their planes. Reversed circular currents under similar circumstances repel.

3 

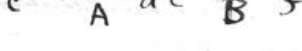
When the line joining their centres is ~~at~~ ~~quite~~ inclined to their planes — ~~Direct circular the~~

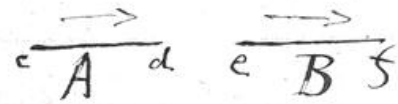
Better Consider one current as fixed and the other as movable.

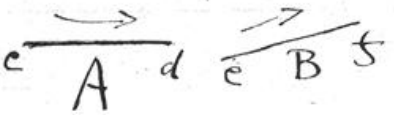
Currents in the same plane.

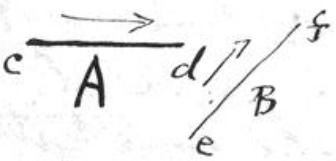


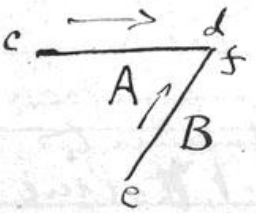
1. Direct. Near side of B is repelled and far side attracted. Theoretically B as a whole is repelled. Practically it will be repelled a short distance (1) and then the plane of B will turn at an angle to the plane of A. (3) The near end of B will be repelled to one side and the far end be attracted so that the plane of B will slide across the plane of A (4) till the far end of B comes in to contact with the rim of A (5) and the ~~plane~~ planes of the two currents will form an angle. ~~The two planes (which first attracted one another)~~ The angle closes - The currents attract one another and finally the circular currents are in close contact - in parallel planes ~~and~~ with their centres touching. (6) These steps are shown in Fig. 1. 2. 3. 4. 5. 6.

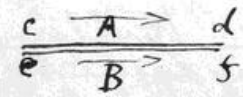
1. 

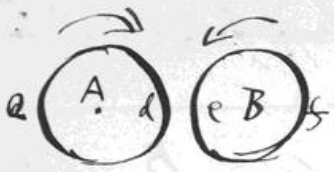
2. 

3. 

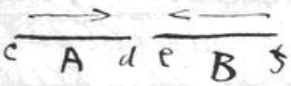
4 

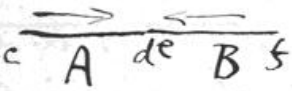
5. 

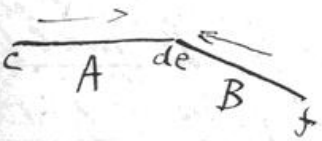
6 



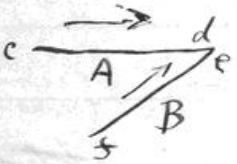
Reversed. B is attracted by A.
Theoretically B should be at rest when e touches d (2) — but practically it will incline to one side or the other (3) and then the attraction of c & f will tend to close the angle (4) until ~~the planes~~ f comes into contact with c and the planes are parallel and the centres touching.

1. 

2. 

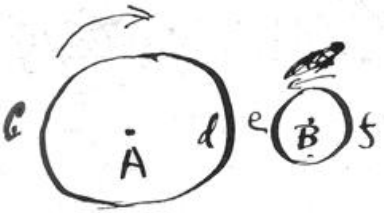
3. 

Generalizing. Circulate currents of equal diameter act upon one another in such a manner that they ultimately come together with their planes parallel — their centres in contact — and their currents flowing in the same direction. So that circular currents free to move would build themselves up into a string of circular currents the planes of all being parallel and the centres in one straight line at right angles to the planes of the currents ~~see~~ See fig 5.

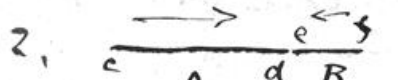
4. 

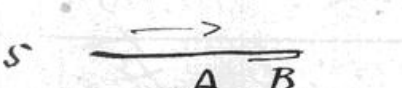
5. 

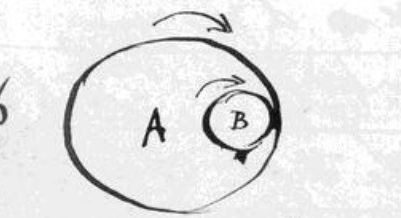
Consider circular currents of different diameters

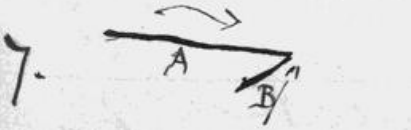


Circular currents of ~~same~~ unequal diameters act upon one another so that ~~that~~ they ultimately come together with their planes parallel and the smaller within the figure of the larger and with their rims in contact.









Flat coils of unequal diameters would remain at an angle to one another as in Fig 7 depending upon the relative diameters of the two coils. Follow this train of thought out.

AGS

Dec. 10th 1877.

1.  1 & 2. Conclusions same as last page.

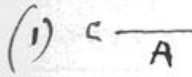
2. 

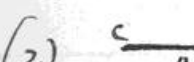
3.  3. Flat coils of uniform size. Same results as in simple circular currents.

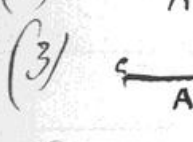
4. Flat coils of unequal size.

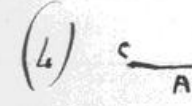
4. 

(1) Same as all circ. currents
(2) " " " "
(3) " " " "
(4) Will B become parallel to A with point e & d in contact or will it remain permanently at an angle. More likely latter for the turns of A beside the side of B repel the latter.

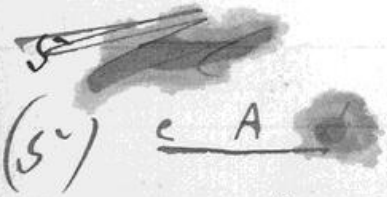
(1) 

(2) 

(3) 

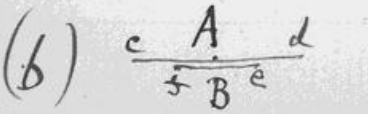
(4) 

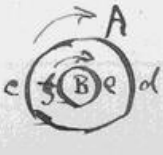
5. As c & f attract and as the attraction of e for d is no more than its attraction for any other part of A between d & the centre it is more probable that the point e will slide along the surface of A.

(5') 

(5") 

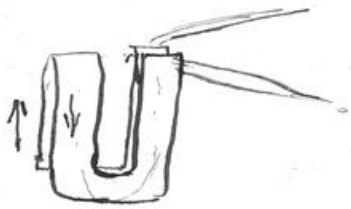
6 And ultimately B will settle parallel to A and the centres of A & B will be in juxta-position.

(6) 

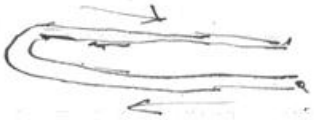


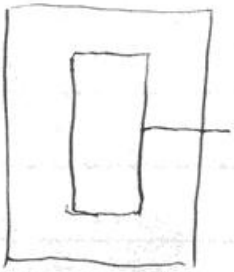
Dec. 11th 1877 Inflation of ventricle

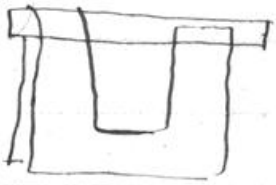
J. Wyllie

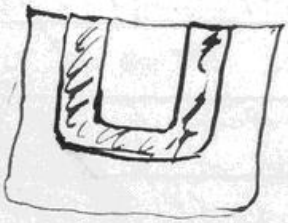


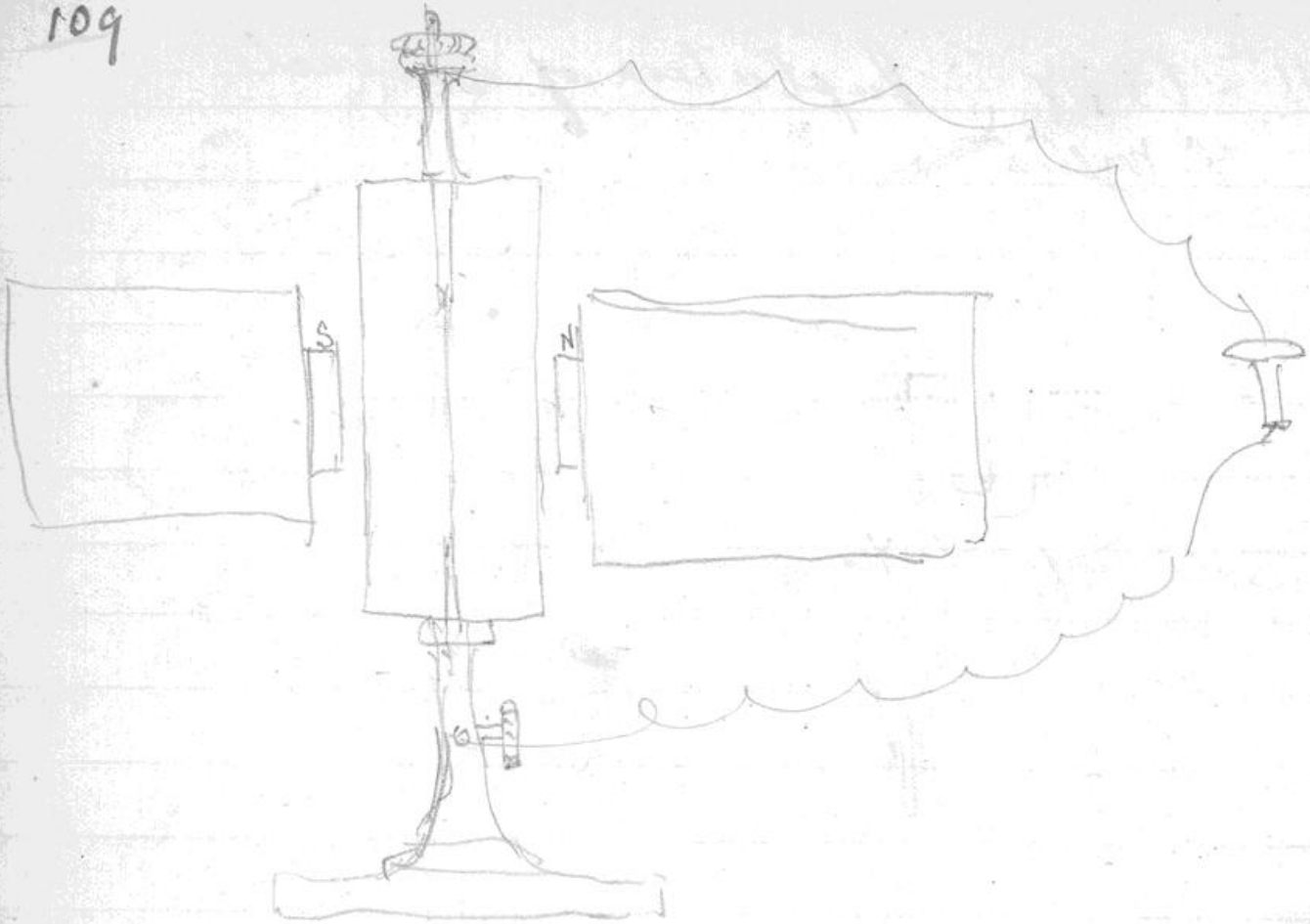
Gold-leaf Electro-phrenometer

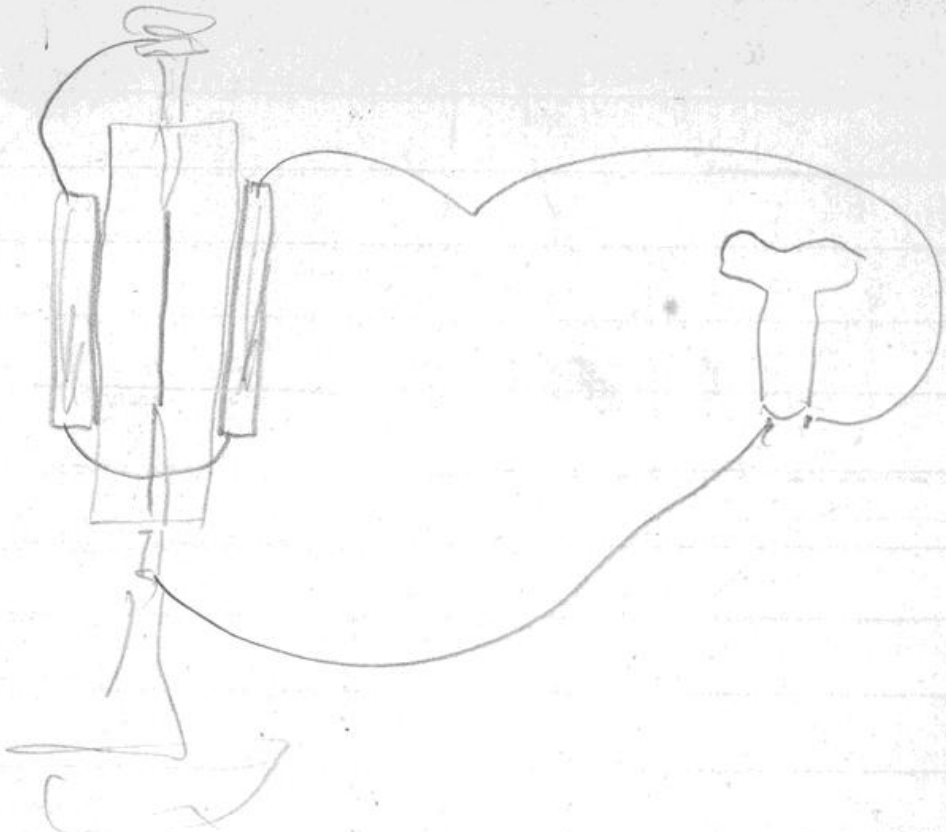




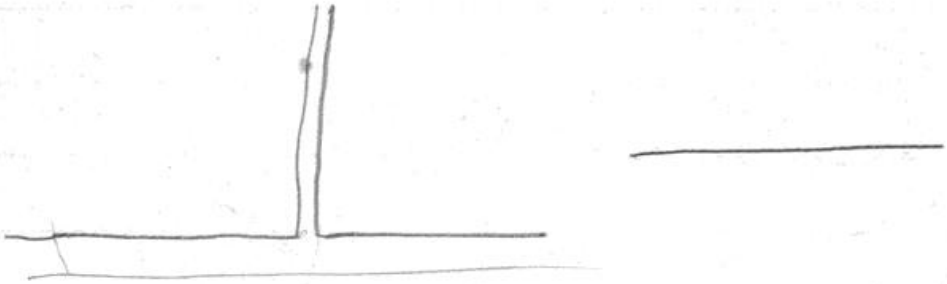


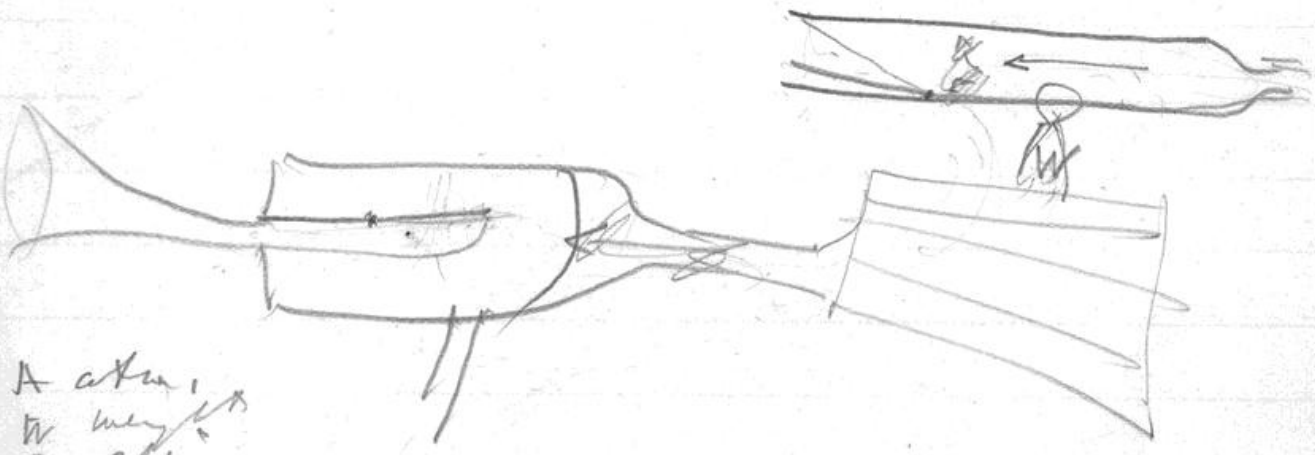



S
N



Watts Dictionary of Chemistry — South Kensington Library —

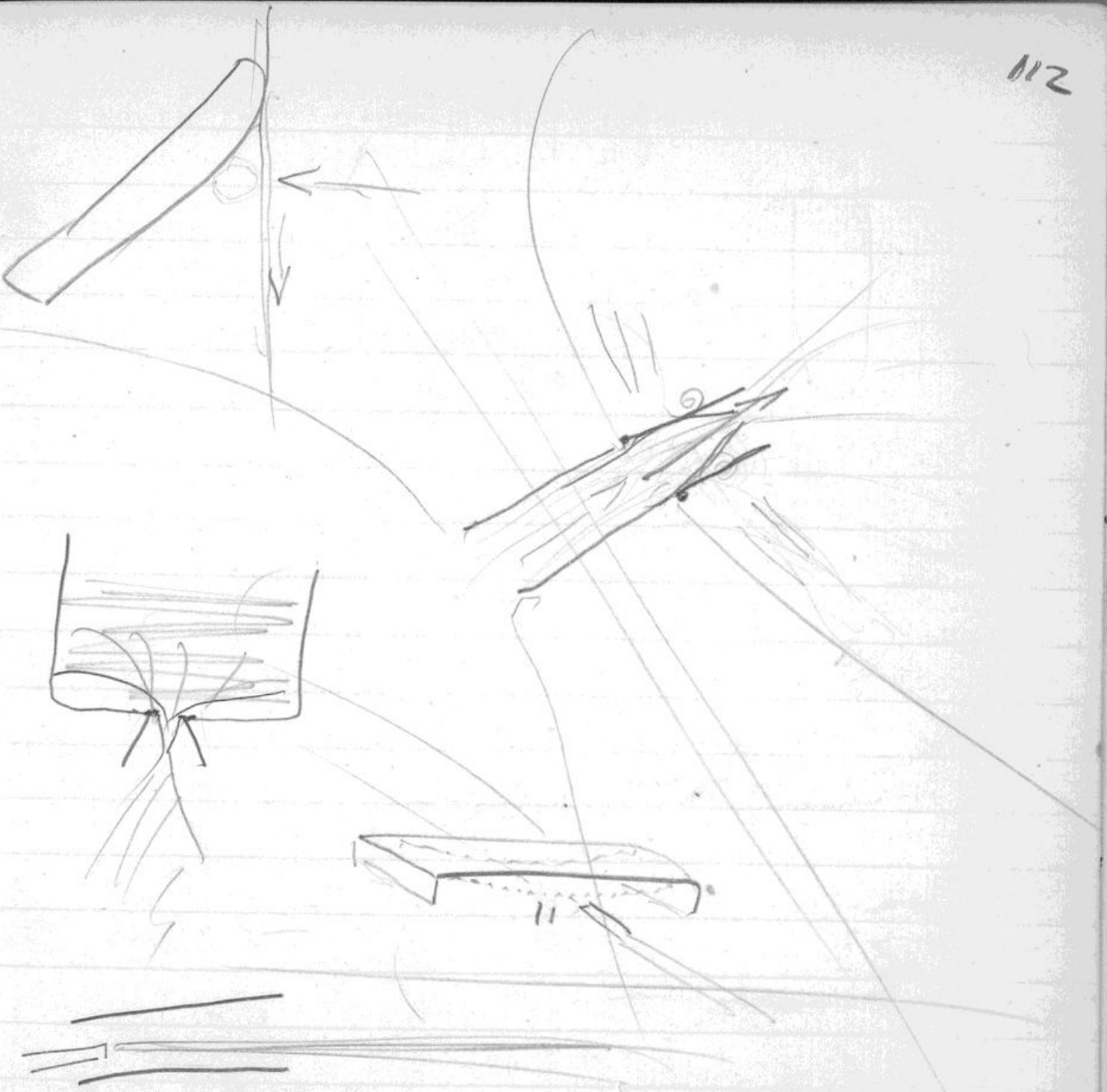


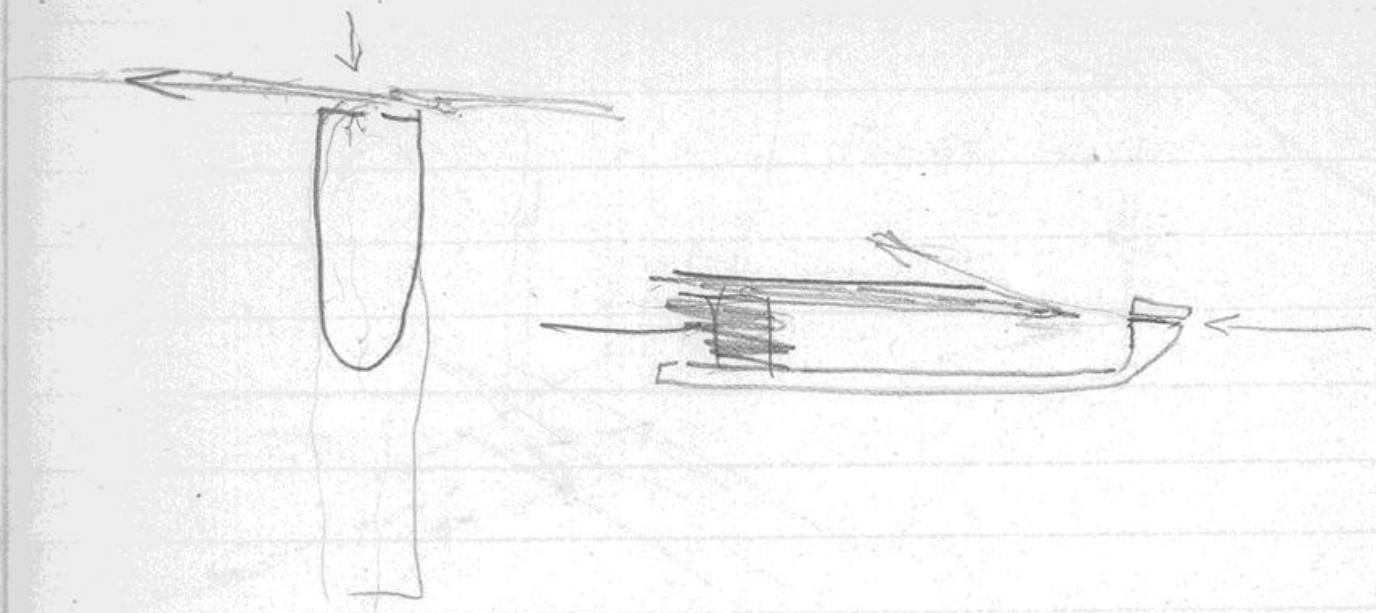


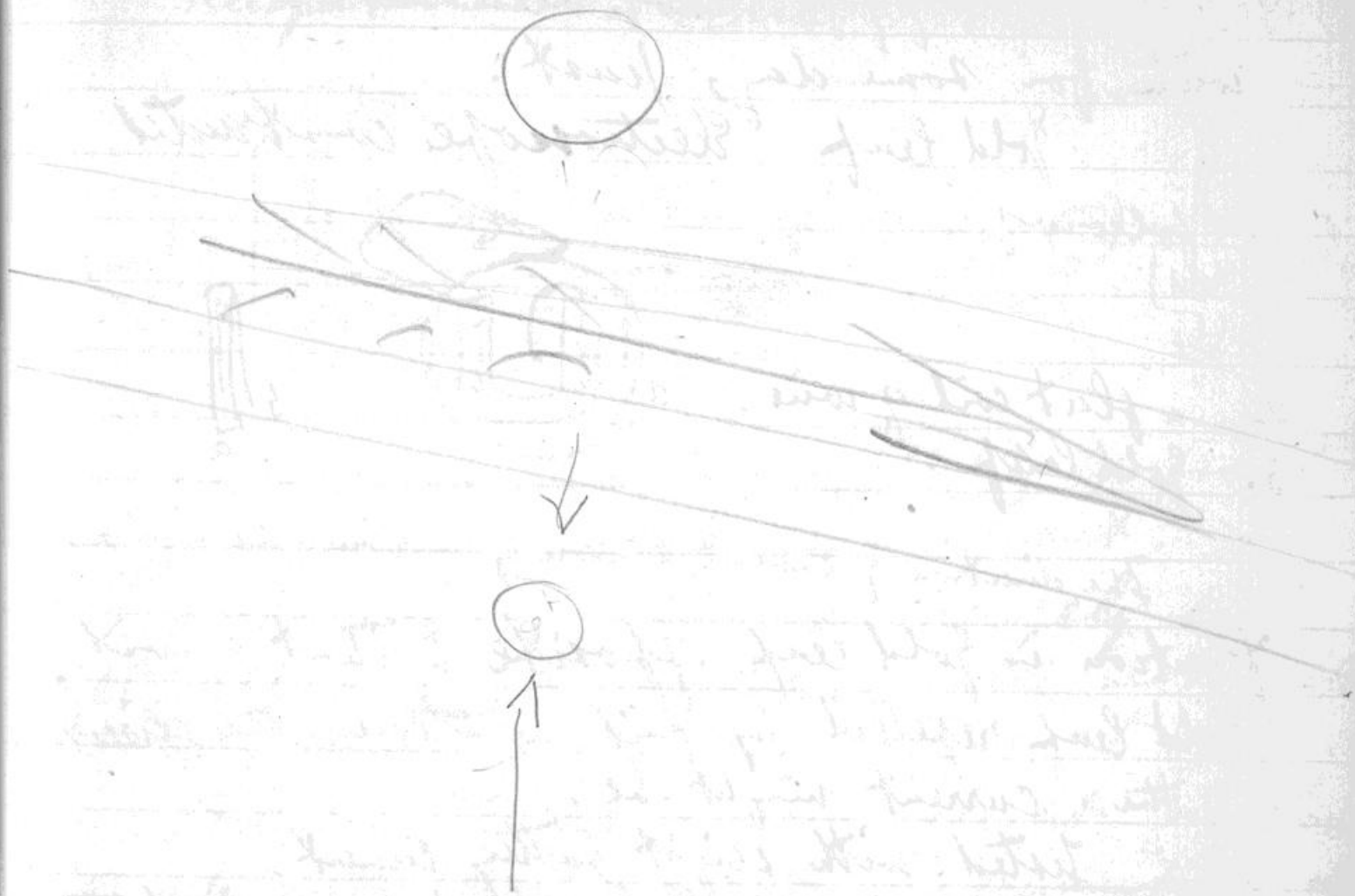
A atm.
W water
S - Spring

$P = A + W$
$P' = A + S$

$P = A + W$
$P' = S + B$

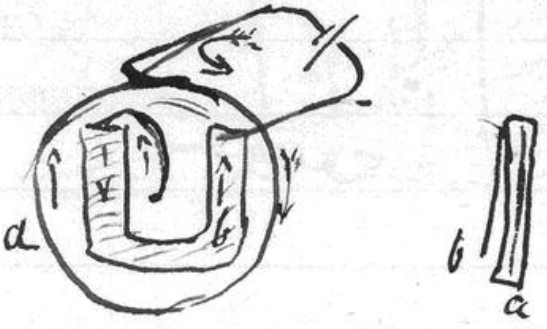






Dec. 20th 1877. Not been able to write for some days past.

Gold leaf Electroscope constructed as follows.



a - a flat coil of wire.
b. Gold leaf.

The direction of current shown by arrow-heads.

Direction in Gold leaf opposite to that in coil.

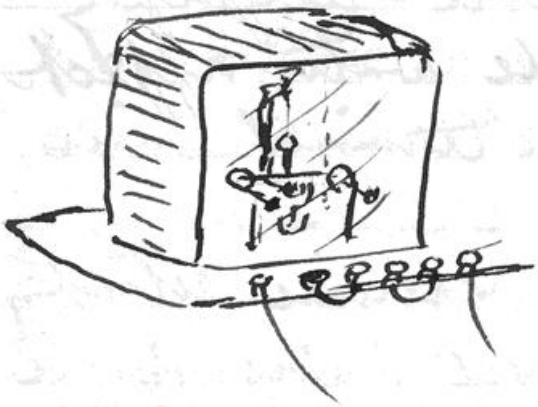
Gold leaf repelled by coil whatever the direction of the current might be.

Tested with slight battery current -

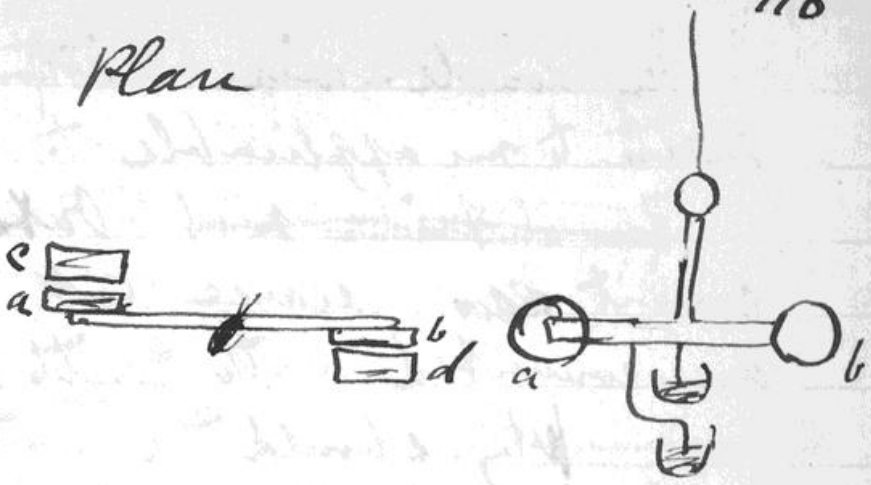
Gold leaf was repelled whichever way battery was connected. No movement perceptible with Telephone current.

Instrument shown on page 63 has been made but in a very crude manner. It is shown as made (on Page 116).

Perspective



Plan

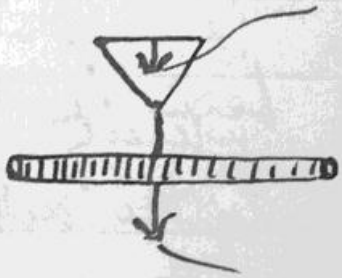


The moveable coils were repelled by the fixed coils whichever way the current went.

The whole instrument crudely constructed and not sensitive. Tested with feeble battery current & obtained motion at once.

Fancied I could observe slight motion of a, b, with telephone but instrument must be reconstructed

Solenoid Galvanometer shown on page 74 is being constructed & should be finished tonight. Slight difference in mode of support. Solenoid needle supported as shown here.



W. Ackland writes that Solenoid is readily deflected by current. Hope to try it tomorrow.

My double-wire method of neutralizing induction seem to me applicable to Cable-telegraph ~~Outside~~ Outside water affects current because the terminal wires are connected with Earth.

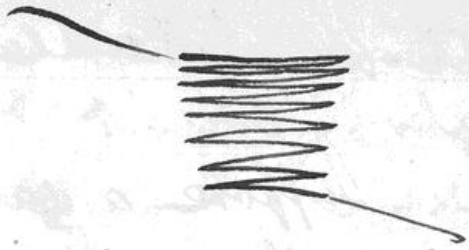
Why should the water exercise retarding action if a return wire is used inside same cable. If one wire exercises retarding influence upon the other it cannot be so great as that due to outside coating for the area is so much less. It seems to me that the double wire should increase the speed of transmission instead of delaying it. ~~For the induction of one wire upon the other will be in~~ For the secondary current induced in one of the wires (A) by the primary current traversing the other (B) will be in the same direction as the primary current traversing it (B). So that any change in the intensity of the current is heightened & intensified by the action of the one wire on the other. It is likely that this principle may be of use as a means of increasing

the amplitude of the electrical undulations.

Suppose a current to be sent round a coil of wire as in Fig 1.

The current is enfeebled ~~when it is first~~ upon first starting – for since the primary currents traverse parallel wires in the same direction the secondary currents induced in the parallel wires oppose the action of the primary currents. So long as the primary current is of uniform intensity no inductive influence is at work. It is only on first starting that it is opposed. But every fresh variation in the intensity of the primary current is resisted initially by secondary currents — so that a constantly varying current like telephone current is constantly resisted by secondary induction. This may be the reason why coils extending down magnets to the centre & beyond – exercise so little influence in increasing volume of sound. What would be the effect of passing current through

arrangement like this.



Prim. Current would pass in opposite direction in parallel wires. Secondary currents would therefore be in same direction as primary currents and would thus assist.

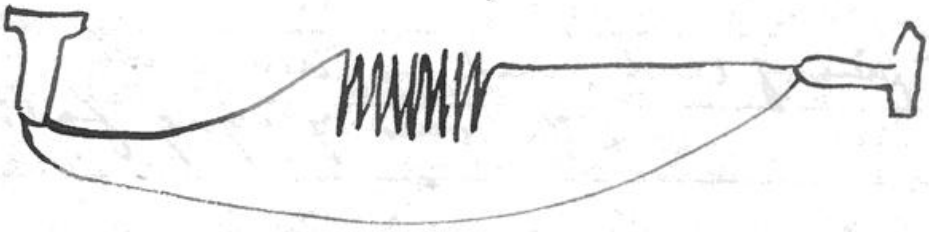
Therefore a current at first starting would be assisted instead of opposed — but if continued of uniform strength no induction would be manifest. While therefore such an arrangement of wires would be of no use with a constant current except at the start — it would be of material assistance with a current constantly varying in intensity. The effect would be to magnify the variations of intensity — to increase the amplitude of the electrical undulations & thus to increase the volume of sound.

Try following experiment. Take two wires (A & B) of equal length & resistance, form one into a coil of ordinary construction & form the other into a zig-zag like that shown above.

Introduce them alternately into Telephone circuit & observe the difference of effect. Arrange upon circuit as follows.

A

B

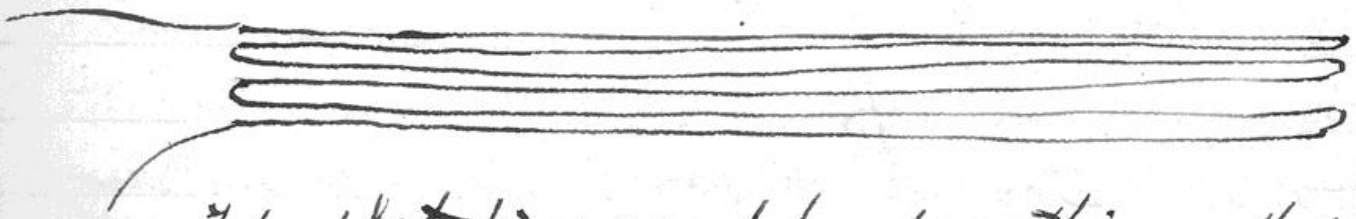


Will B give louder sound than A – & can the interposition of an apparatus like B be used to increase the intensity of current for overcoming resistances?

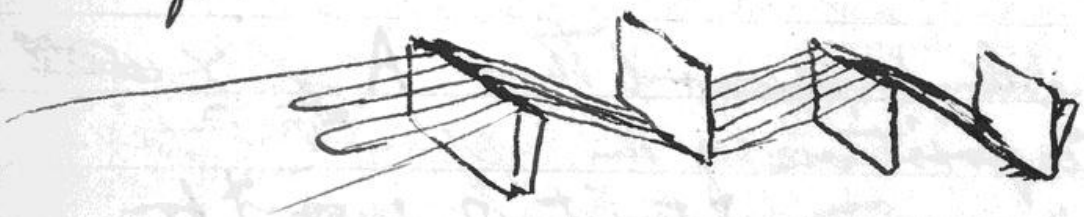
It certainly is the case that a coil of wire especially with iron core – damps the sound much more than the mere resistance of the wire of the coil can do – and why should not arrangement B increase the sound. Easily tried.

Dec. 22d. Been thinking a great deal of Current Intensifier shown on the preceding page. The more I think of it the more feasible does it seem.

Make a Current Intensifier in the following manner. Stretch a wire in following manner so as to make parallel wires about six feet in length.

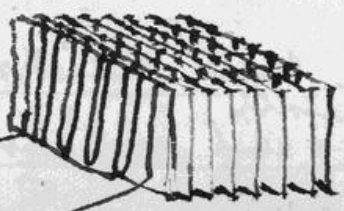


Take flat pieces of card board or thin wood as paper and ~~interlace them~~ bend the wires zigzag fashion as follows



Bring these together so as to be as close together as possible and make following arrangement

Would this arrangement intensify the sound by increasing the amplitude



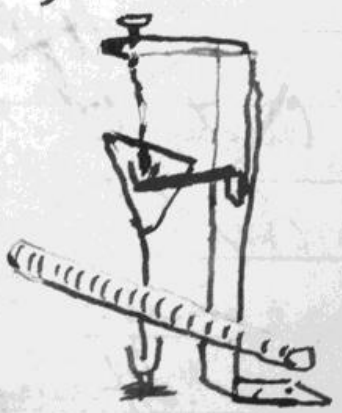
of the electrical undulations? It seems to me that it would.

Solenoid arrangement shown on pages — 65, 74, & 116 completed yesterday — but upon ~~test~~ trial the coil was found to be defective. The solenoid was all right & was attracted or repelled by magnet just like magnetized needle. It was difficult however to get the needle to hang with its axis perpendicular. The mercury cups were of steel & repelled the mercury. Thus the surface of the mercury drop was convex upwards and the steel needle dipping into it was repelled to one side of the drop instead of hanging vertically.

I have sent the instrument to Mr. Cleland (1) to have coil investigated and repaired —

(2) To have mercury-cups made of material which does not repel mercury — to try brass tinned inside — and

(3) to have a silk fibre arranged so that the needle may be suspended by it if deemed advisable.



Dec. 23rd 1877 George Minchin writes to me in reference to experiment No 5 page 94 that the intensity of a current is the same in every part of a circuit. Chester however points out that the definition of intensity viz - $I = \frac{E}{R}$ really indicates that intensity is the amount of flow and not the velocity of the flow. So that the analogy may hold good after all.

The question arises - If the velocity of the current varies in different parts of the circuit - how can its velocity be tested?

Is the heat generated a measure of the velocity of the current?

After all I do not see that Chester is right. $I = \frac{E}{R}$ can be explained

Yes he is. No he is not.

But if

If by intensity is meant the amount of flow - then the same amount of ~~electricity~~ fluid passes each cross section

of the wire in the same time — and there will be equal amounts of flow in equal lengths of wire.

Now let your circuit be of a certain length (L) and the quantity of current (Q) that passes in unit of time will be $Q = \frac{E}{L}$

But $I = \frac{E}{R}$ and if you divide your circuit into sections each having the same resistance but not necessarily the same length — then your equation signifies that the strength of the current in each of your segments is equal — whatever is meant by strength. Probably the meaning is that the fall is the same — the difference of potential between the initial & final points of each segment is the same. This then would make "intensity" mean really "velocity" of motion. $I = \frac{E}{R}$. The electrical "fall" will be the same in sections of the wire offering the same "resistance" to the passage of the current.

But equal lengths of wire of different thicknesses offer different resistances — the thin wire offering most resistance. Hence in equal lengths of thick & thin

wire the electrical fall will be greater in the thin wire than in the other — that is the intensity will be greater. This is exactly the proposition shown in experiment 5 page 96 — and it is evident that the intensity of the current varies inversely as the cross-section of the wire.

In this case then "intensity" is equivalent to "velocity" of flow.

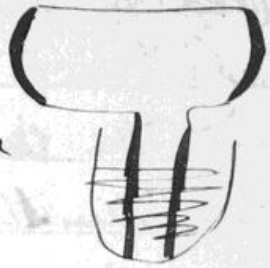
The "quantity" of flow is the same whatever the cross section of the wire.

The "Quantity" of flow is the same at every point of a circuit but the "Intensity" at any point depends upon the cross-section of the wire.

Treating the subject mathematically, $I = \frac{E}{R}$ but $R = CL$ where C is the cross section of the wire and L its length.

$R = CL\,r$ r being a constant expressing the specific resistance due to the material employed. r would be slight in copper & great in iron &

If we consider the potential of our circuit as uniform and merely consider the difference due to different resistances.



$$R = CLr \therefore L = \frac{R}{Cr}$$

That is the resistance of equal lengths of wire is inversely proportional to their cross sections and to their specific resistances.

$$I = \frac{E}{R} = \frac{E}{CLr} \therefore CLr = \frac{E}{I}$$

$$\therefore L = \frac{E}{ICr}$$

Putting E as unity then $L = \frac{1}{ICr}$

Ignore r and let $R = CL$

Then $I = \frac{E}{R} = \frac{1}{R} \therefore I = \frac{1}{CL}$

It is evident from the equation $I = \frac{E}{R}$ that (E) expresses the total intensity of the circuit — or the summation of the intensities observable at the different parts of a circuit for $E = RI$. Consider I as

Velocity of flow signifying the amount of "fall" in unit of length — then I varies with the cross section — and E may be considered as the total fall of the circuit.

Consider the analogy of a river.. (River)

E is the total fall of the river from its source to its mouth — the difference of elevation between the water at its source and at its mouth

(2) Let the river run down an inclined plane from its source to its mouth so that the rate of fall in the bed of the river

I The velocity of the river will

Quantity varies directly as the cross-section.

Resistance varies directly as the length & inversely as the cross section

Dynamic Electricity

E is the total fall of the circuit – the difference of potential between the two elements of the battery.

2. Let the circuit be composed of the same material throughout so that the specific resistance may be the same at any part of the circuit.

$$Q = \frac{E}{L} \qquad I = \frac{E}{R} = \frac{E}{CL_2}$$

$$E = QL \qquad \therefore E = ICL_2$$

$$\therefore QL = ICL_2$$

$$\therefore Q = IC_2$$

$$I = \frac{Q}{C_2}$$

That is the intensity is directly proportional to the quantity and inversely proportional to the cross-section & to the specific resistance.

(River) Analogy between river

A river flows from its source to its mouth.

1. Total amount of fall ~~—~~ vertical distance from ~~mouth~~ source to mouth

2. Total length — horizontal distance from source to mouth.

3. Mean Rate of fall — mean amount of fall for unit of length — found by dividing total fall by total length.

~~Absolute rate~~ ~~True rate of fall~~

a. ~~Real rate of fall~~ ~~The fall differs at~~ ~~The~~ the amount ~~The fall differs at~~ ~~The diffe~~

b. The rate of fall differs ~~at~~ different parts of its course. It is found by finding amount of fall in ~~a~~ given unit of length.

~~Velocity~~

5 ~~b~~ The same ~~amount~~ quantity of water passes each cross-section of river ~~at a~~ in the same time.

b ~~The~~ The velocity of the river varies with the rate of fall and with the area of cross section of the river. It is proportional directly to the ~~rate~~ rate of fall & inversely proportional to the cross-section of river.

current of Electricity (Elect. Current)

An electrical current flows from one element of the battery to the other.

1. The Electro-motive force depends upon the difference of potential of the two elements of the battery.

2. The total length of circuit is the length of wire uniting the elements of the battery.

3. The mean intensity of the current is the mean amount of fall for unit of length — and is found by dividing the electro-motive force by the total length.

4. The mean intensity of different portions of the circuit differs. It is found by finding the amount of fall in unit of length.

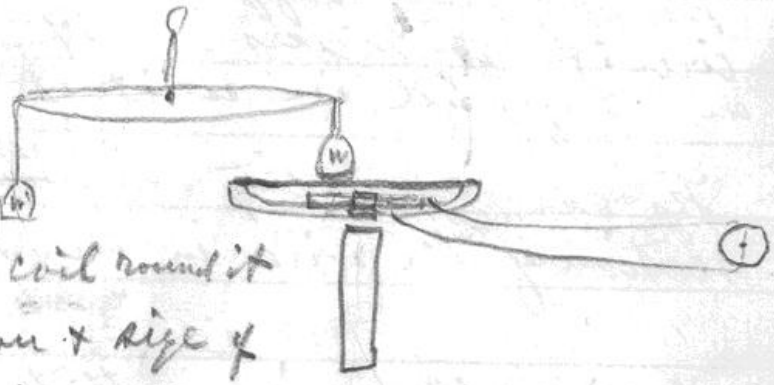
5. The same quantity of electricity passes each cross-section of the wire in the same time.

6. The intensity varies with the specific resistance of the wire & with the cross section of wire.

The intensity is proportional directly to the specific resistance and is inversely proportional to the cross section.

Dec. 25th 1877 An ordinary galvanometer can be employed in order to discover best mode of arranging parts of telephone. Strike plate ~~&~~ with a uniform force so that it moves only towards ~~from~~ magnet. Vary parts & note deflection.

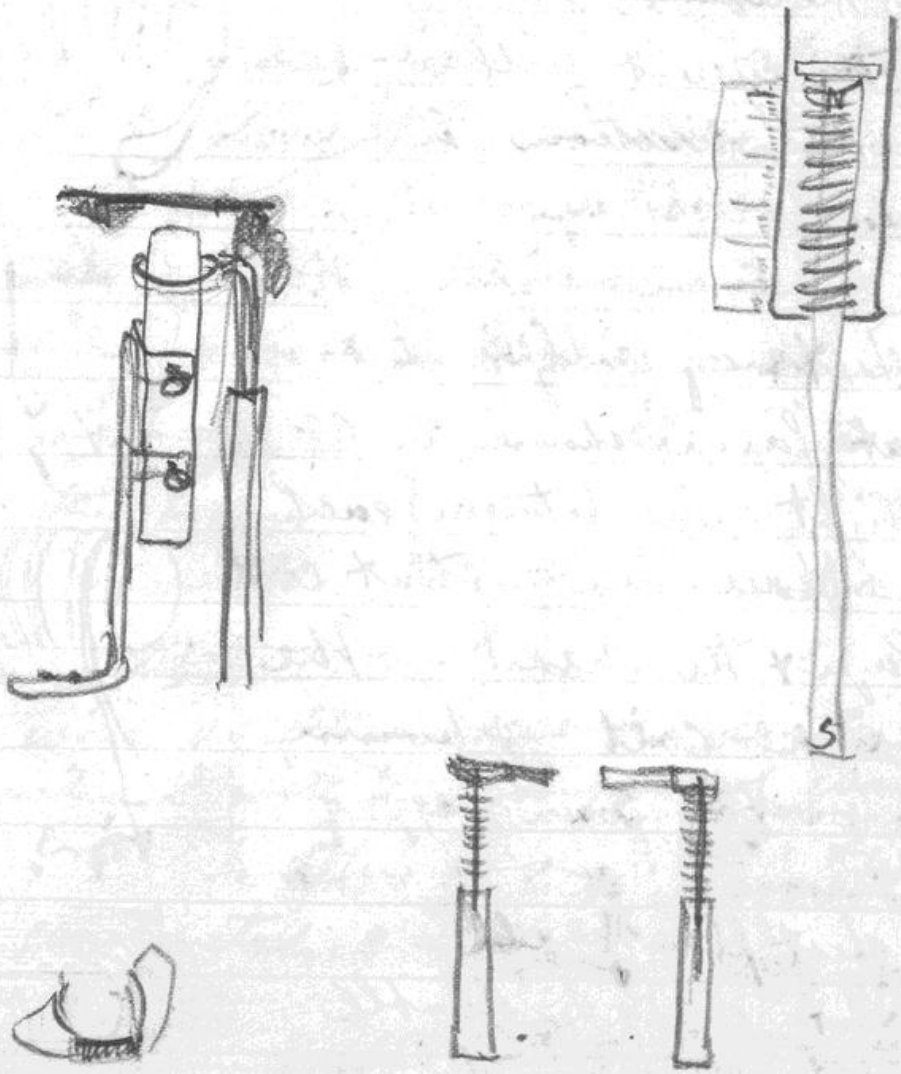
It seems to me that the best way of producing the motion of the plate is to rest weight upon it — keeping it almost balanced by another weight. Remove ~~one~~ counterbalance & former weight exerts its full force — & there will be little or no rebound.



Make soft iron core with coil round it and begin by varying power & size of magnet. Arrange a series of magnets of different sizes ~~and~~ measure the sizes of magnets & test their power by means of delicate balance.

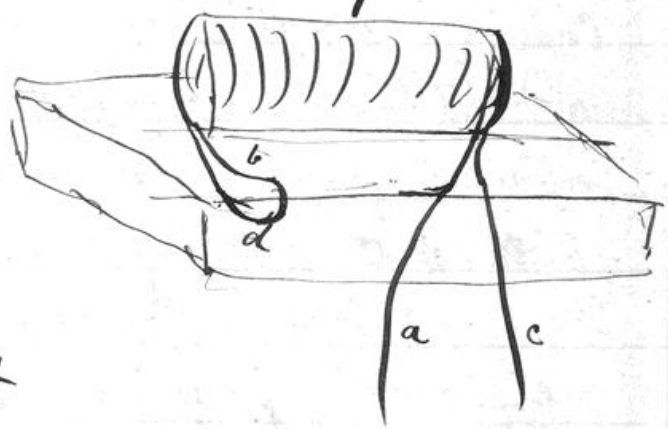
Efficient means of testing power of single pole magnet. Put a plate of iron upon a coiled brass or german-silver coiled spring

and place magnet inside. Draw down magnet and note the point of scale reached when magnet can no longer hold ~~off~~ plate



Dec. 26th 1877. Double wire idea grows in value. Simplest way of making current intensifier will be to construct a coil of two wires a b & c d side by side, & unite two of the terminals d b so that the current will pass in opposite directions in parallel wires.

Fig 1



Perhaps best way will be to construct first layer as shown in Fig 2. Slight space between each pair. Then place piece of stout card between that layer & the next. The result will be a coil shown in section in Fig 3.

Fig 2

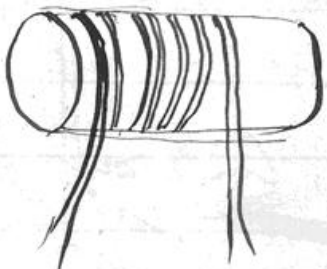
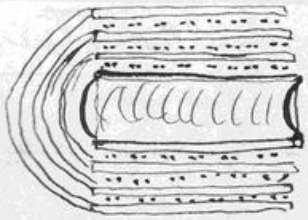


Fig 3

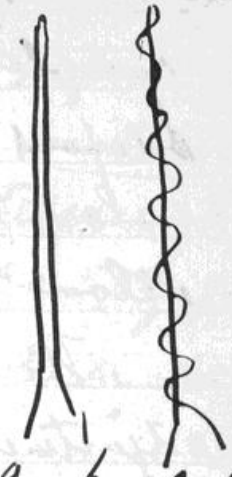
Perhaps best plan of all is to construct coil of double wire in which the one insulated wire is coiled round the other.



"The action of a sinuous current is equal to that of a rectilinear current of the same length "in projection" Ganot's Physics Par. 834.

However near you place the parallel wires a + b there is still a slight space between them but in the case of c + d — d is equivalent to a rectilinear current which may be actually considered as coinciding with c.

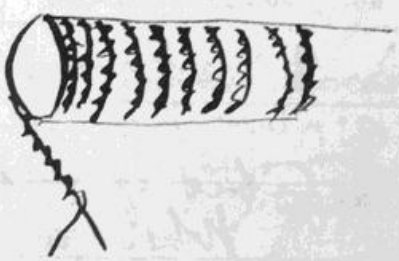
Fig 4



Hence the inductive influence of cd upon neighbouring wires — or the inductive influence of neighbouring wires upon it — is nil — whereas the inductive influence of the one wire (c) upon the other (d) is at a maximum.

Coil an insulated wire round another wire and then make a coil of usual construction with the compound wire as in Fig 5. In this way may be constructed a "current-intensifier"

Fig 5

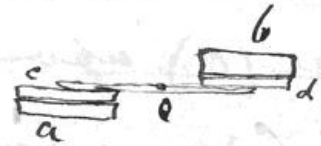


The coiled wire may be considered as a rectilinear conductor coinciding superposed upon the other wire — but of greater resistance than it.

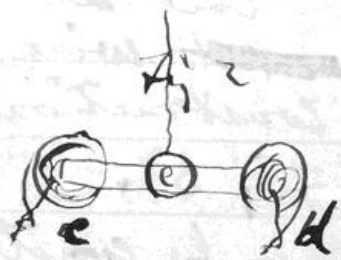
Dec. 28th 1877. Solenoid Galvanometer completed yesterday. Won't work. Solenoid-needle & supports too heavy. Mercury cups so large that the upper one did not allow room for needle to turn freely.

The solenoid needle requires more delicate adjustment. The electro-dynamometer constructed by Foster was more delicate. If it could only be freely suspended without the trouble of mercury-cups — it would be delicate. Try Induction electro-meter. Good thought.

a & b are two fixed coils through which current from telephone is to be passed.



c & d are coils of fine wire — each coil being distinct & separate. The two terminals of the coils are united together as in Fig 2.



A mirror — e — is attached to the centre of a light arm of aluminium and the whole is suspended by means of a fibre of unspun silk.

When a current passes through coils a & b. currents are induced in the coils c & d in an opposite direction — hence repulsion should take place and the mirror be turned. So long as the primary current

is of uniform intensity no induction takes place but any change in the intensity of the current will occasion induced currents in c & d. Hence the current from the Telephone should constantly generate induced currents in c-d - and a constant repulsion be manifest.

Dec 29th, 1877. Induction Dynamometer won't work. For the current induced will be opposite to primary current only when primary current is increasing in strength but will be in same direction while primary current decreases. Thus there will be alternate attraction and repulsion & consequently no motion with Telephone current. How will this affect Current Intensifier (pages 133 - 134)

As prim. cur. increases - secondary currents will be in same direction & make increase greater - as primary current decreases Second. cur. will be in opposite direction & diminish the current still more. It is all right.

Amplitude of Electrical Undulation will be increased.

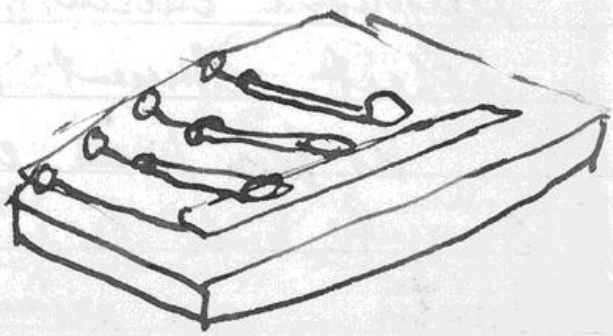
Tested four telephones with mirror galvan. Two Silvertown & two American. Treated in membrane firmly with penknife & zero deflection.

Double-pole portable Silvertown	15°
Single-pole Silvertown (bad order)	6° or 8°
Single-pole American	15°
Double pole American (Reporter's Telph)	190° or 195°

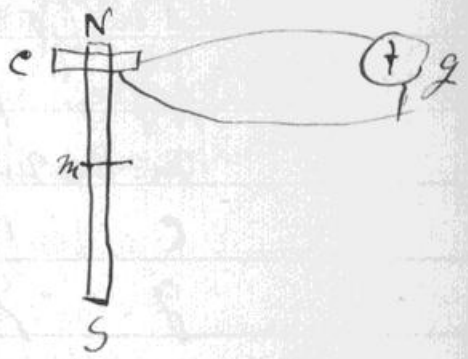
It is evident that this method of testing will give good results.

While thinking out details of apparatus for adjusting every part — have Testing Keys made like diagram.

Long three Keys.



Dec. 30th 1877. Experiments with straight bar magnet & coil, & galvanometer.



1. C moved down towards m.
   ~~Gate~~ deflect. to right. + defl.
2. C. moved from S to m. + defl.
3. C. moved from m to N — defl.
4. " " " " " S — defl.

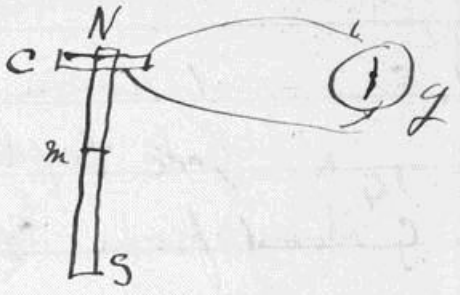
Coil reversed

5. Coil moved from N to m — defl.
   m to S + defl.
   S to m — defl.
   m to N + defl.

Dec. ~~29th~~ 30th Experiments with Galv.

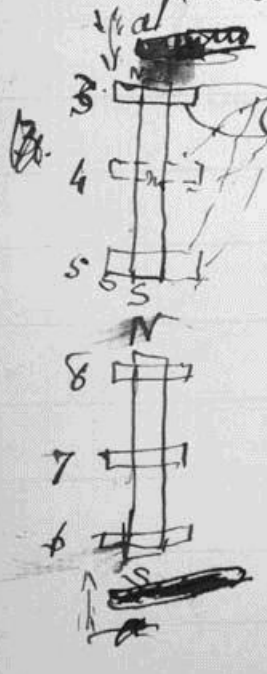
To test the motion of coil upon magnet.

+ defl. = defl. to right.
− defl. = defl. to left.
N & S Poles of magnet.
m Middle point
C Coil
g. Galvanometer.



	Coil moved			Coil moved	
1.	C moved from	N to m	+ defl.	2. N to m	−
		m to S	−	m to S	+
		S to m	+	S to m	−
		m to N	−	m to N	+

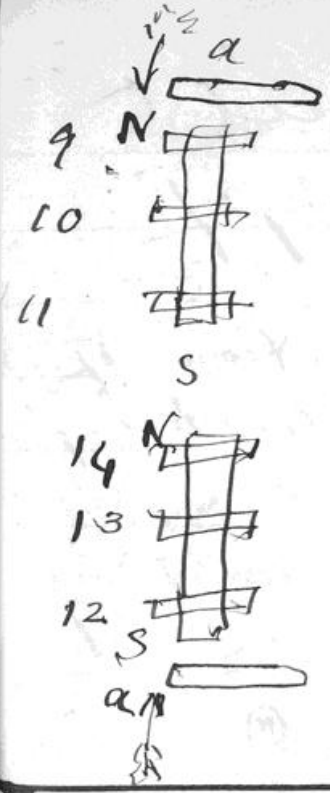
Influence of locality of coil upon current produced by approach of armature.



Armature moved uniformly with same force as nearly as can be done by hand.

		(1st time)	(2d)
3 gave	+ deflection	98°	+ 98°
4 "	+ "	15°	+ 20°
5 "	+ "	10	+ 10°
6 "	+ "	80	+ 95
7 "	+ "	21	+ 12
8 "	+ "	12	+ 9

Left handed winding



Coil reversed

	1st	2nd
9	− 60°	−100°
10	− 25°	− 17°
11	− 7°	− 10°
12	− 85	− 60°
13	− 20	− 18°
14	− 7°	− 7°

Right [illegible]

Right to [illegible]

Vessels [illegible].

[illegible], coil steady & [illegible]

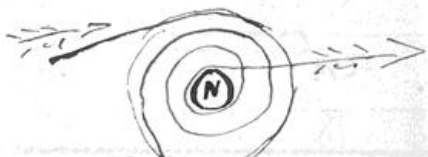
Over

To avoid confusion it will be well to be more precise in defining meaning of different terms.

In considering the direction of the winding suppose yourself to be looking down upon the north pole of the magnet

Look down upon north-pole of magnet.
Direction of winding to be considered from outside to inside.

Right handed coil



Left handed coil

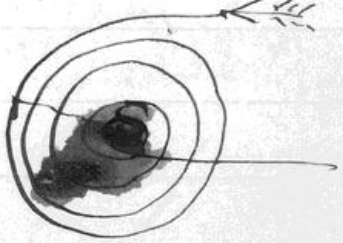
Right handed coil. Move arm. tow. S pole gives + deflect.

Mot. of coil fr. S to middle —— + defl.

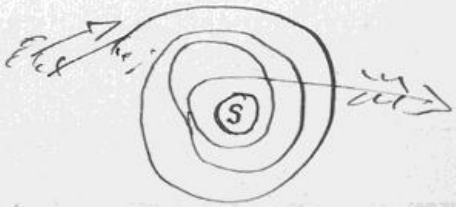
Mot. of coil fr. middle to N —— — defl.

Mot. of arm towards N pole gives + S

Right handed coil

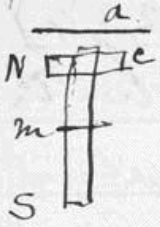


Left handed coil

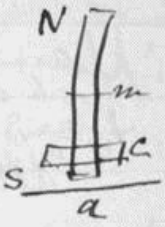


Results

Left-handed coil.



Arm. moved towards N gives + deflection
Arm. moved towards S gives + deflection
Coil moved from N to m gives + deflection
Coil moved from S to m gives + deflection



Right-handed coil.

Arm. moved towards N gives — defl.
Arm. moved towards S gives — defl.
Coil moved from N to m — defl.
Coil moved fr. S to m — defl.

Generalization

Motion of the armature or coil towards the centre of magnet gives + defl. with left-handed coil.

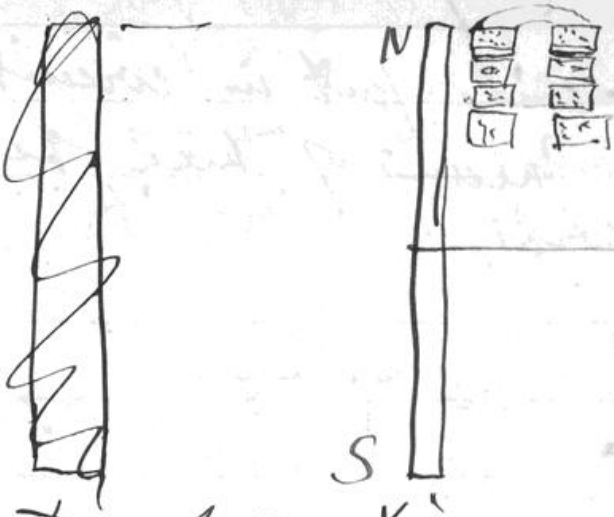
142

Arrangement of coil. Four coils Taken of about equal (but unknown) resistance (1, 2, 3, 4) all plant in circuit. Deflection noticed with a b c d
~~1 2 3 4~~ upon magnet.
all coils Left-handed.

		1st	2d	3d	Average
1.	a. gives	80°	79°	79	
	b —	80	68°	70°	
	c —	82	68	70	
	d —	80	~~69~~	~~50~~	
	a b	100	149	125	
	b c	139	145	145	
	c d	140	125	125	150
	a b c	151,	125,	140,	160, 170
	b c d	190,	160,	165,	175, 175
	a b c d	201,	250,	270,	150, 245,
		248,	220,	290,	255 245,

Thickness of each coil — 3/8 inch.
Diameter exterior — 1 1/2 inches
— interior — 1/2 inch
Length of magnet — 5 7/8 inches
diameter of magnet — 1/4 inch

Drawn to scale



Average of ten observations.

1 coil	2 coils	3 coils	4 coils
80	100	15-1	201
79	149	125-	250
79	125-	140	270
80	139	160	150
68	145-	170	245-
70	145-	190	248
82	140	160	220
68	125-	165-	290
70	125-	175-	255-
80	150	175-	245-
Total 756	1343	1611	2374
Average 75.6	134.3	161.1	237.4
Ratios 1	1.8	2.1	3.1

Dec. 31st. 1877. Left handed coil on N pole.

Six coils put in circuit.

Means of five observations:

All coils in circuit.

Experiment.

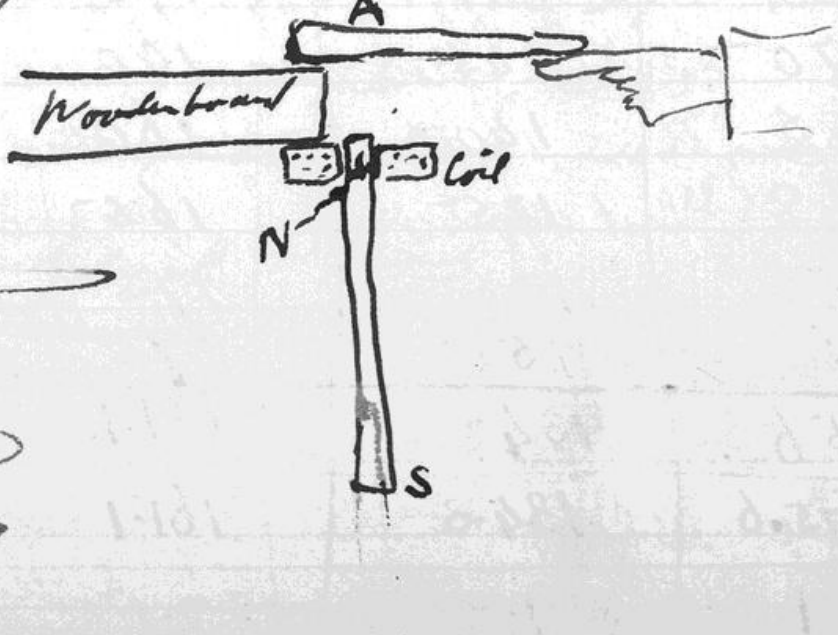
1. 166°	2. 238°	3. 243
4. 208	5. 304	6. 274

Means of three observations

Coils not upon magnet cut out of circuit.

1. 160	2. 271	3. 245
4. 283	5. 263	6. 277

The armature consists of a pair of wire stippers held about ¾ inch from the pole & then suddenly allowed to fall upon pole.



The great variation in the individual readings shows that a large number of observations is necessary & some more uniform method of moving the armature. The free end of armature is supported on hand and the displ. is greater or less according to the height of the hand.

Shall try & keep ~~[illegible]~~ armature horizontal.

Experiments to test method of winding coil. Have taken an insulated copper wire 12 ft in length and coiled it in diff. ways round magnet.

Partic. of wire.

Wire Length - 12 ft. diameter .025- Silk covered.
"But copper wire - high conductivity"

Magnet. ~~Partic~~ Length 5-7/8 inches diameter 1/6 inch. ~~[illegible]~~
Power ?

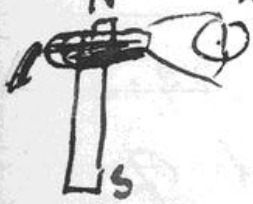
Armature Slotted Steel wire - cutter slightly polarized.
Held horizontally as in preceding page.

146 Left handed turns round north pole.

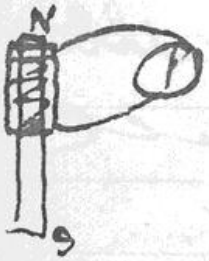
Mean of Ten obs.

1 turn, No defl. observable
2 turns No defl. observe.
3 turns No defl. observe.
4 turns 2° 1° – so slight cannot be certain
10 turns very slight & uncertain
20 turns very slight but decidedly + deflection
40 turns + deflection – uncertain how much.

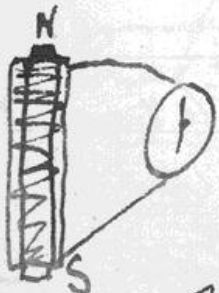
12 ft. 1 wire coiled left handedly around north pole.



8°, 5°, 5°, 4°, 3°, 3, 3, 2°, 4°, 3° — 4°



3°, 3°, 2°, 2°, 3°, 3°, 2°, 3°, 2°, 3° — 2.5



2°, 2°, 2°, 3°, 2°, 4°, 3, 4°, 5°, 5° — 3.2

The total deflection is so small & variations in the force of the fall so great that ~~nothing can be judged of the~~ The above results ~~are~~ unsatisfactory & unreliable. Try greater amount of finer wire & take deflection from breaking contact between magnet & armature.

I find I have four flat coils made by Mr Foster of different thicknesses of wire. Coils are of ~~silk~~ uniform size.

Coils. Ext. diam. 1 inch Interm. diam. 3/8 inch. Thickness 1/8.

Diameter of wire.	Deflections	Mean deflection
.014	+ 10, 10½, 10½, 11, 7, 10, 10, 10, 11, 10,	10.0
.005	32, 45, 40, 40, 25, 30, 20, 20, 23, 20½,	29.5
.002	No circuit — Coil broken somewhere.	
	American coils. ~~Exter. diam. 1 inch. Interm~~ Exterm. diam. 1½ inch. Ext. diam ½ inch Thickness 3/8 inch. Thickness wire as nearly as can be judged by eye about .005" in	
.005?	145, 130, 70, 170, 165, 161, 155, 180, 125, 137,	143.8
	Another American coil. Ext. diam. 1 inch. Interm. diam. 3/8. Thickness ¼ inch. No 38 wire. 68 ohms resist.	
No 38	45, 110, 90, 90, 95, 80, 85, 80, 70, 70	80.5

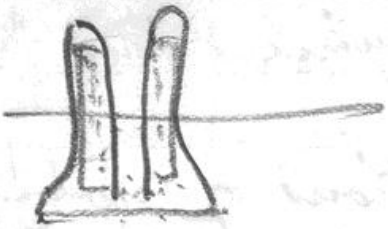
A Glasgow coil made by W. White.
Ext. diam. 1 inch. Interm. diam. 3/8. Thickness 3/8.
Thickness of wire .005
Resistance 47½ ohms. Number of turns 620.

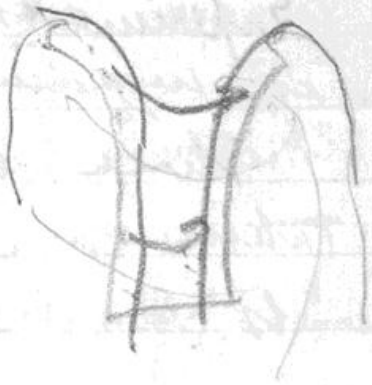
Diam. of wire	Deflections	Mean of ten observ.
.005"	80, 82, 60, 70, 70, 50, 50, 55, 50, 58,	62.5

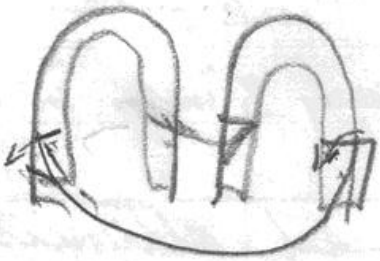
Does magnet grow weaker after each sounding stroke? Try effect of breaking contact. See if we get more uniform readings.

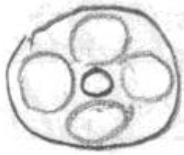
Deflect. obtained with Hark com. coil .005" wide ~~½ ext. diam~~ int. diam.

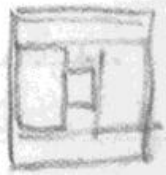
Deflections.	
70, 68, 80, 100, 90	No more uniform than other methods.

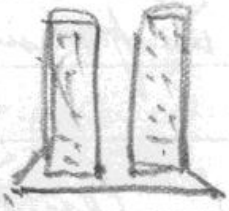












Jan. 2d. 1877 —

Experiments to determine the best mode of winding the wire.

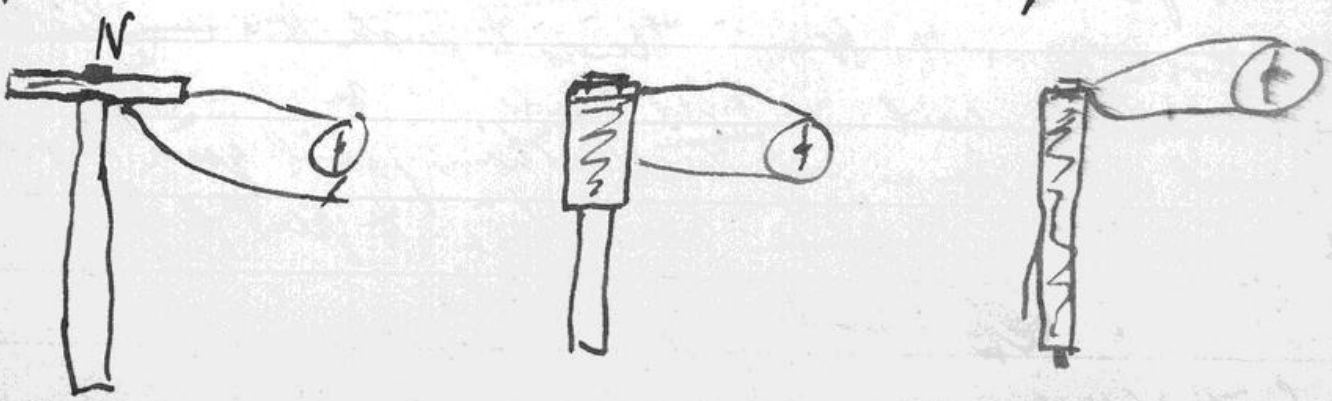
Three equal sections of wire were taken each 15'7 ft. in length and coils made of different lengths.

No 1. a flat coil 3/8 inch thick.
No 2. Coil ~~extending lengthways~~ 3 inches in length
No 3. Coil six inches.

These coils are to be placed alternately upon the same permanent magnet & the deflection noted as in former experiments

~~Magnet practically~~
Magnet six inches in length.

Experiment 1 Exper. 2 Exper. 3



Experiment 1. 35, 30, 29, 30, 32, 40*, 20, 30, 30,
25†, 30†, 32, 39, 31; 33, 32, 32, 34, 40, 33,

Mean of 20 observs. 31.85
Max. 40
Min. 20

Experiment 2. 28, 31, 32, 36, 20, 39, 22, 40, 32, 30, 29
35, 32, 30, 29, 22, 30, 25, 29, 29,

Mean of 20 readings 30.05
Max. 40
Min. 20

Experiment 3. 21, 23, 23, 23, 21, 22, 22, 22, 22,
20, 19, 21, 22, 22, 22, 21, 21, 20, 23, 22

Mean of 20 readings. 21.6
Max. 23
Min. 19

* Struck the coil instead of the magnet.

† Deflection less than it should be for the shock upon the N pole tends to push the magnet down towards the coil & also tends to make the coil rebound upwards — but these motions of coil give deflection of opposite kind — hence neutralize & great accident in value of readings. Fix coil firmly.

‡ Coil plugged.

American Blank Coil -

Exp. 4. 60, 75, 72, 60, 62, 79, 82, 62, 62, 62,

Mean of 10 Readings = 67.6

Glasgow High resist. Coil.

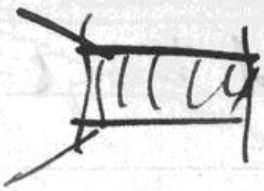
Exp. 5. 202, 197, 199, 160, 175, 180, 195, 160, 165, 160

Mean of 10 Readings, = 179.3

Certainly it is demonstrated that the fine wire & high resistance is the thing - but so far the narrow coil does not seem to possess any appreciable advantage over the coil extending to flexual point. Try experiment again with fine wire Coil.

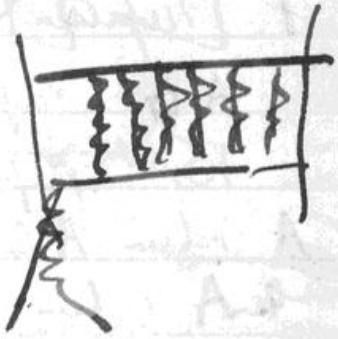
Current Intensifier.

Equal lengths of wire were taken & two coils wound, each = 2 ohms 1 & 2.



No 1

Current in circuit with Telephone.



No 2.

Exp. 1. (Direct Coil No 1) 12, 12, 32, 30, 42, 41, 42, 42, 42, 43, 45, 42, 46, 42 42, 50, 45, 48, 51, 51

Mean of 20 obs. 40.0

Exp. 2 (Current Coil No 2) 50, 51, 50, 51, 50, 48, 41, 45, 51, 42, 42, 49, 49, 50, 50, 45, 48, 49, 50. 47. Mean of 20 obs. = 47.9.

Exp. 3. (With insertion of the coils in circuit)

50, 50,

Must give up working today

June 10th 1878

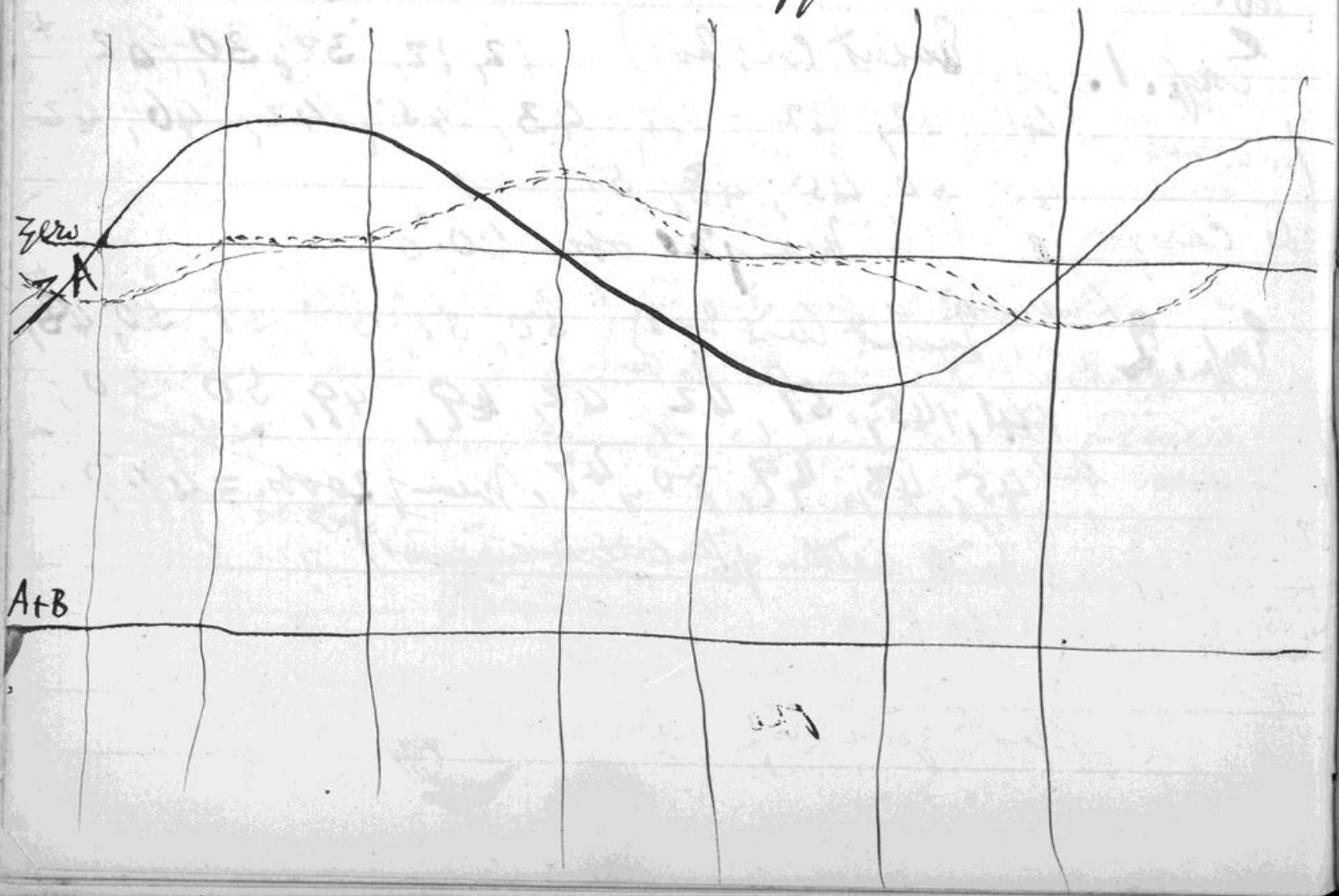
What is the effect of secondary current upon the total result — when telephone current is passed through a coil of ordinary construction.

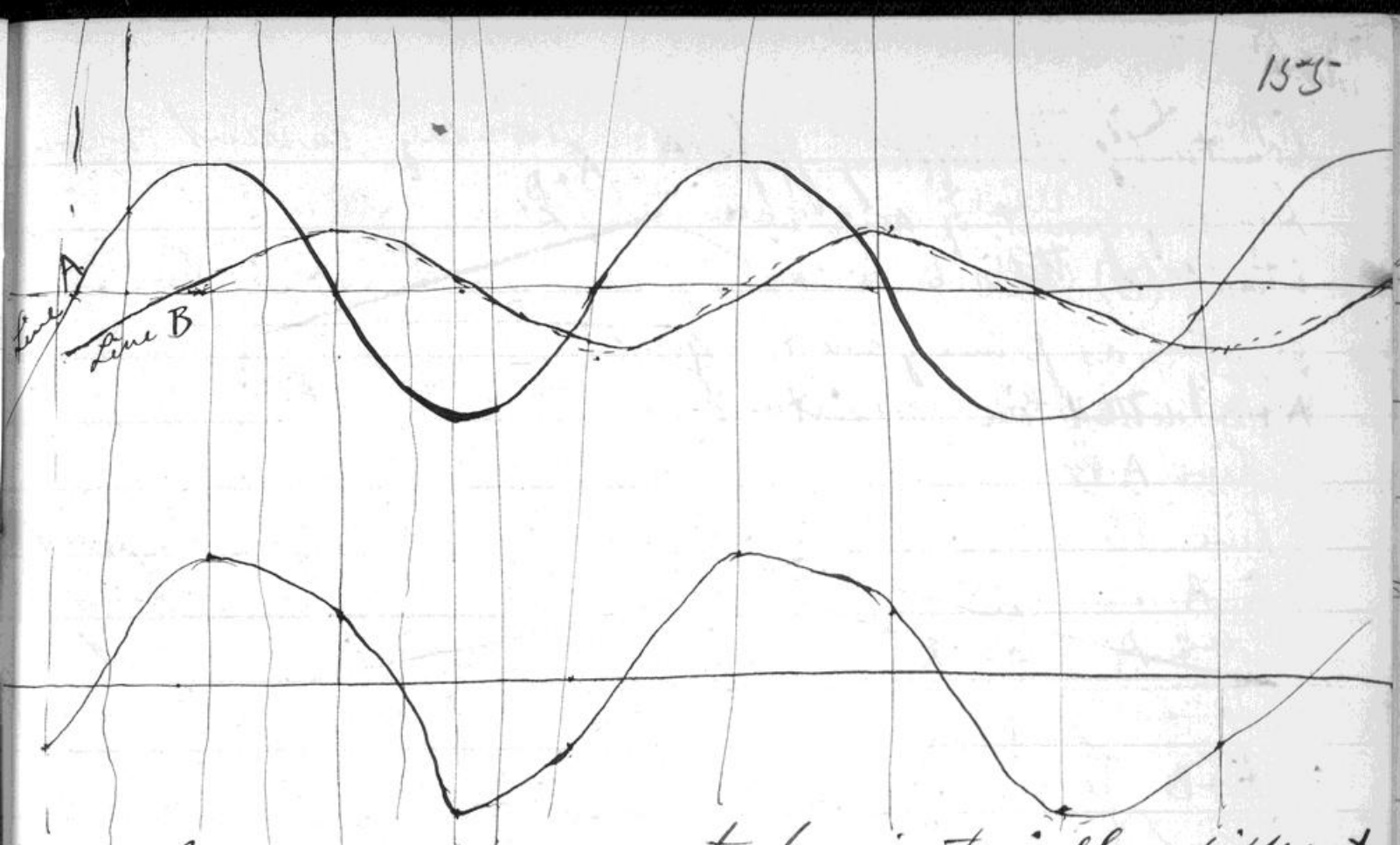
Fig 1. Represents primary current.

Line A represents primary current.

Line B represents secondary current always opposed to A when A is increasing and always of same kind as A when A is decreasing in strength — and B is at zero when the intensity of A does not change

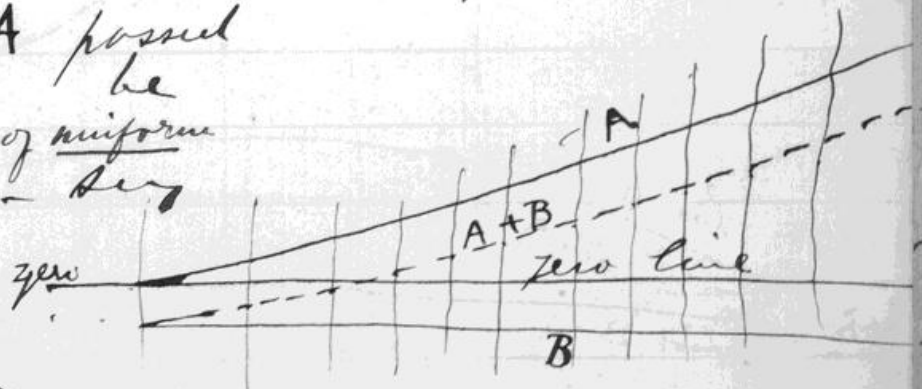
A+B indicates resultant effect.





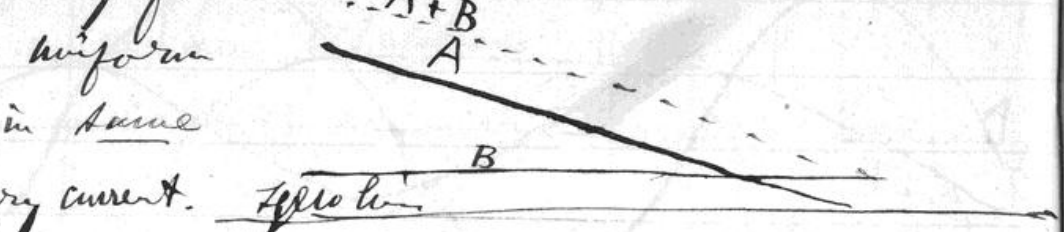
The effect seems to be materially different from what I had anticipated and this must be carefully investigated.

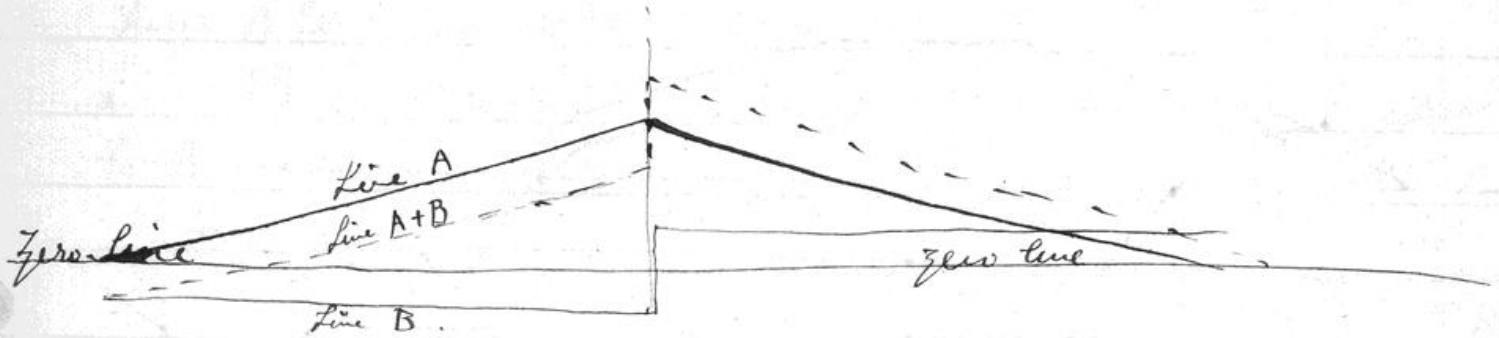
Suppose a constantly increasing primary current as in next illustration A passed through coil. Result would be a ~~uniform~~ bifilar secondary current of uniform strength but of opposite kind — say B. The resultant will then be A + B dotted line.

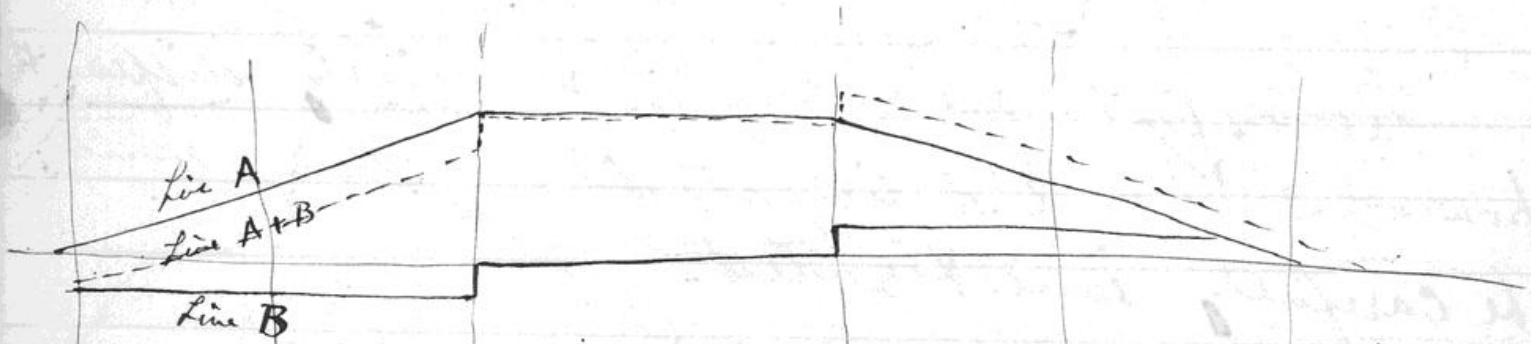


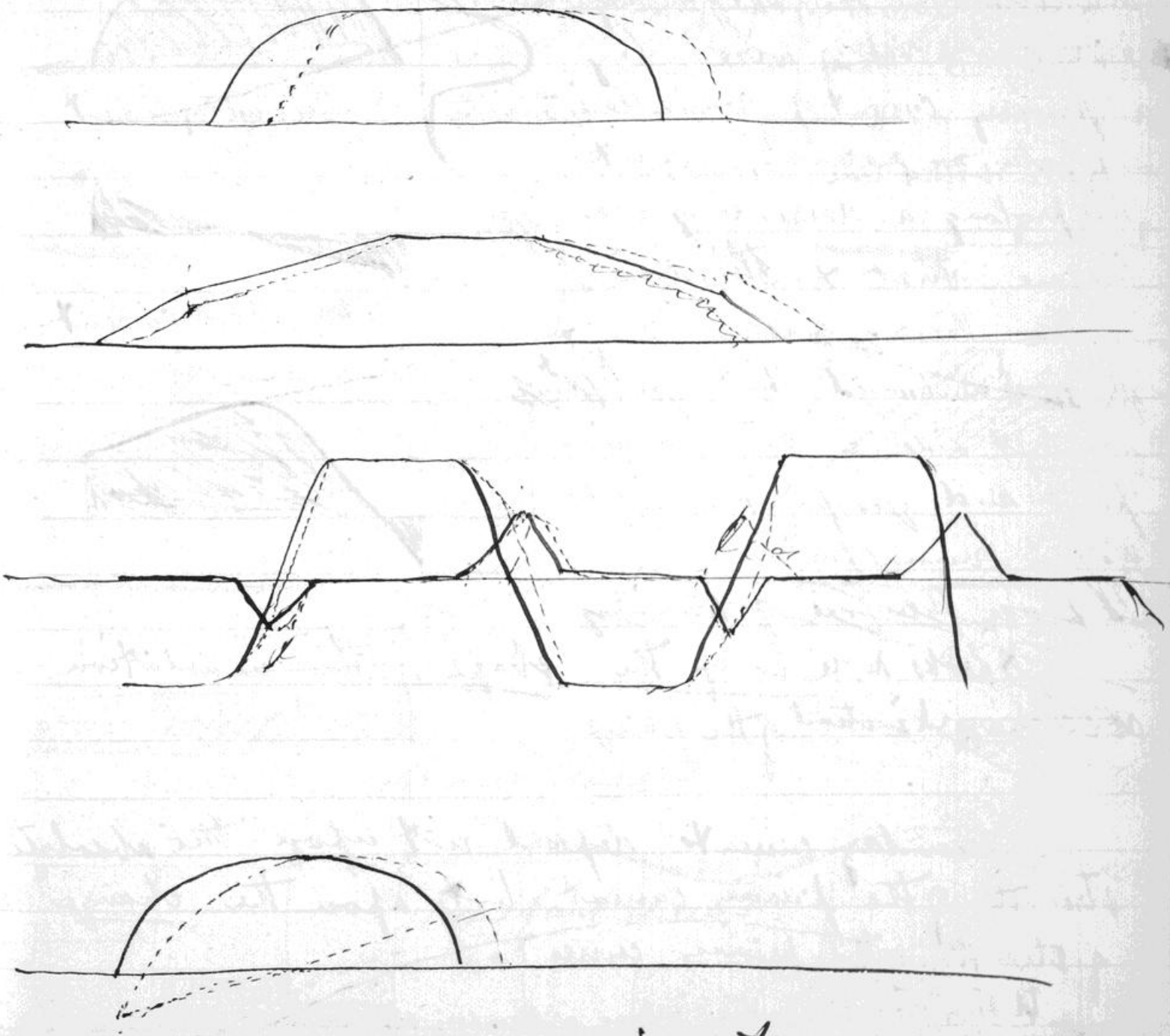
Over

Constantly diminishing force A
Secondary current of uniform
intensity (B) ~~flow~~ in same
direction as primary current. Zero line
A+B dotted line resultant.



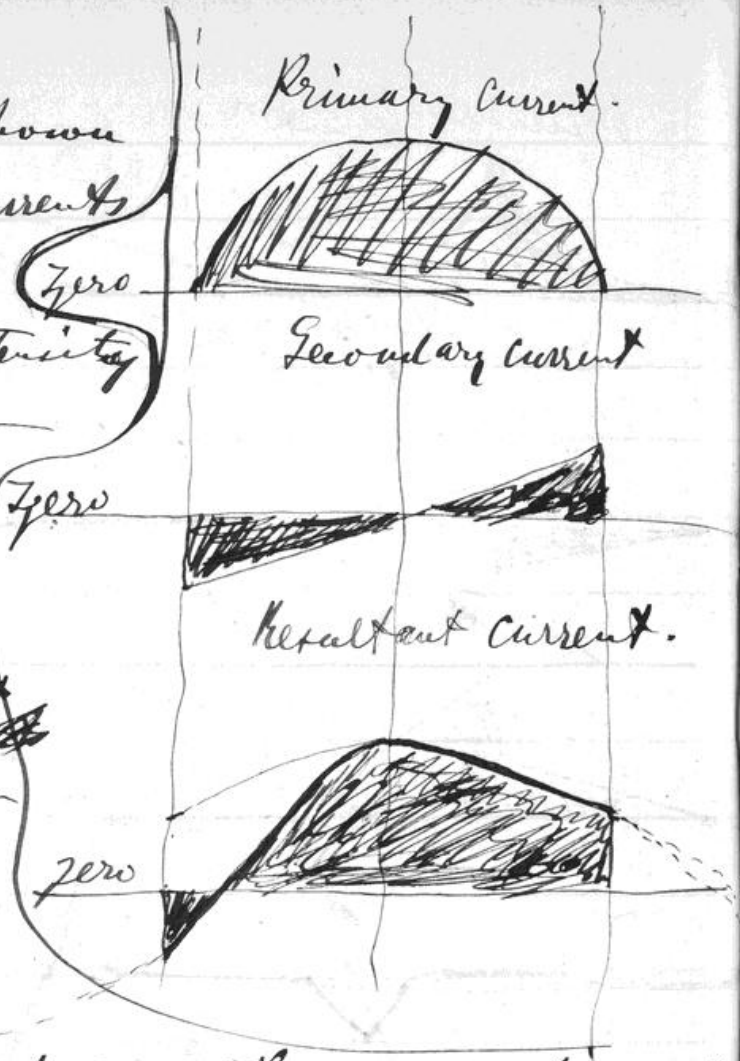






It really seems as if the effect of a coil is more to change the phase of an electrical vibration.

If the calculations here shown are correct — the secondary currents induced in a coil of wire by a primary current of variable intensity — shorten an increasing current — and prolong a decreasing one. Compare First & Third diagram.



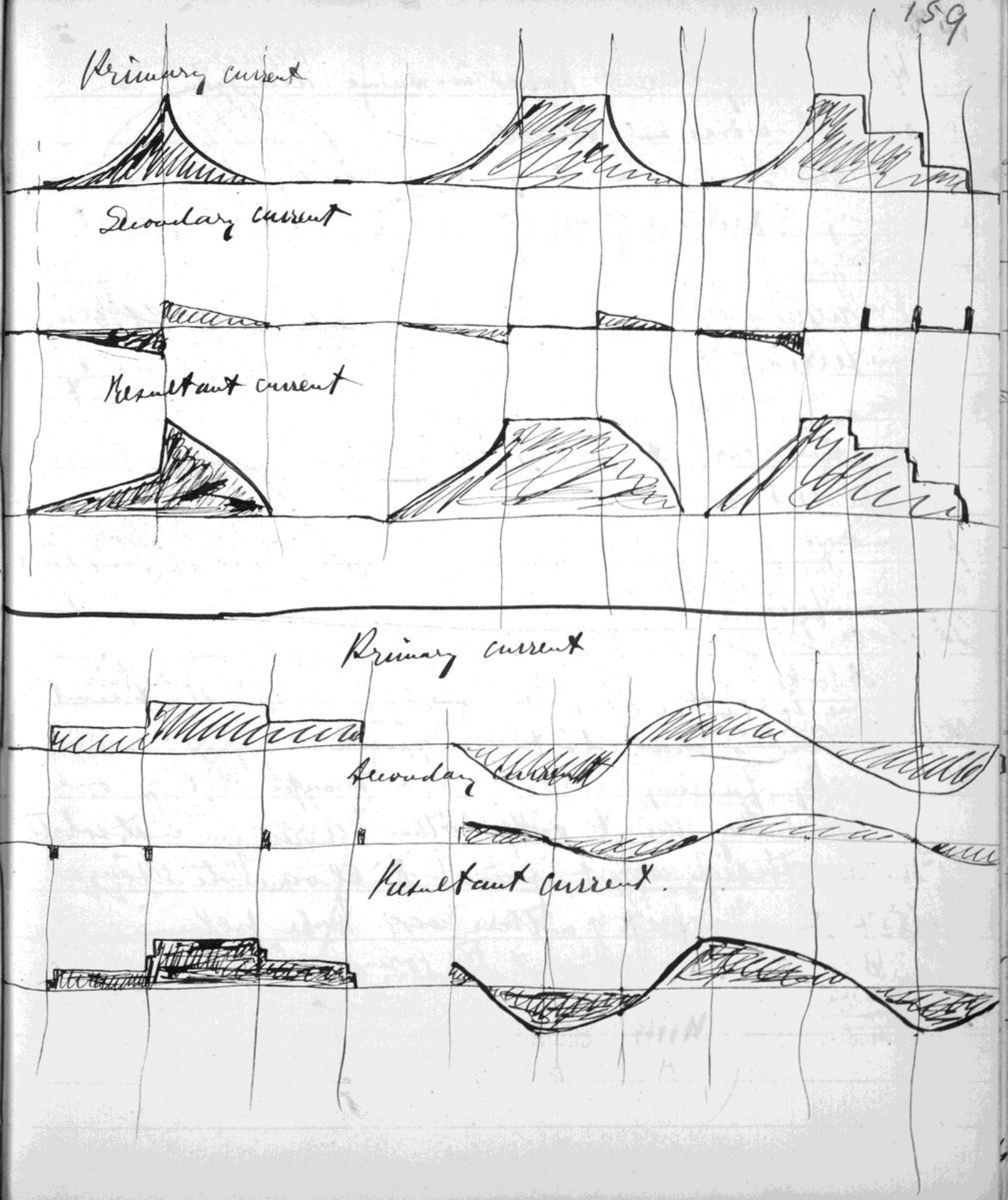
Point of maximum current remains unchanged but zero point on left side is nearer maximum point and zero-point on right side is removed further away.

~~Its phase therefore of~~

It looks more as if the shape of the undulation is changed instead of the phase.

Secondary currents depend not upon the absolute strength of the primary current but upon the change of strength of the primary current.

A sinusoidal vibration induces a secondary sinusoidal vibration the phases of which is different — the wave is of same length but is one-quarter vibration in advance of primary wave


Primary current
Secondary current
Resultant current
Primary current
Secondary current
Resultant current.

When primary current passes in same direction in parallel wires —

Increase of current makes secondary current of opp. kind
Decrease of current

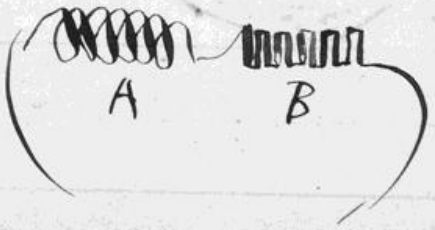
Increase of prim. cur. —— Sec. cur. of opp. kind
Decrease " " " " same "

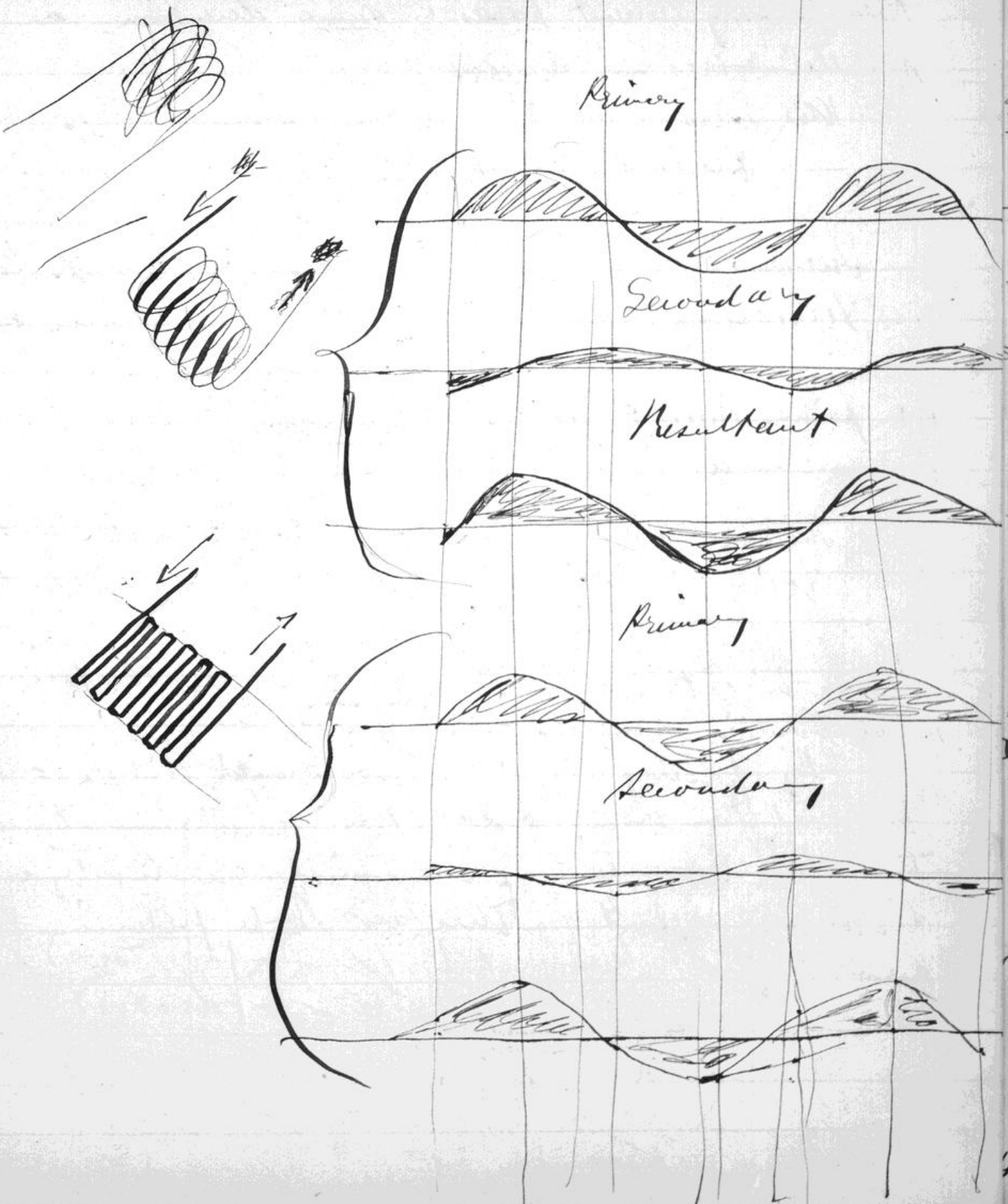
When prim. current passes in opposite direction in parallel wires —

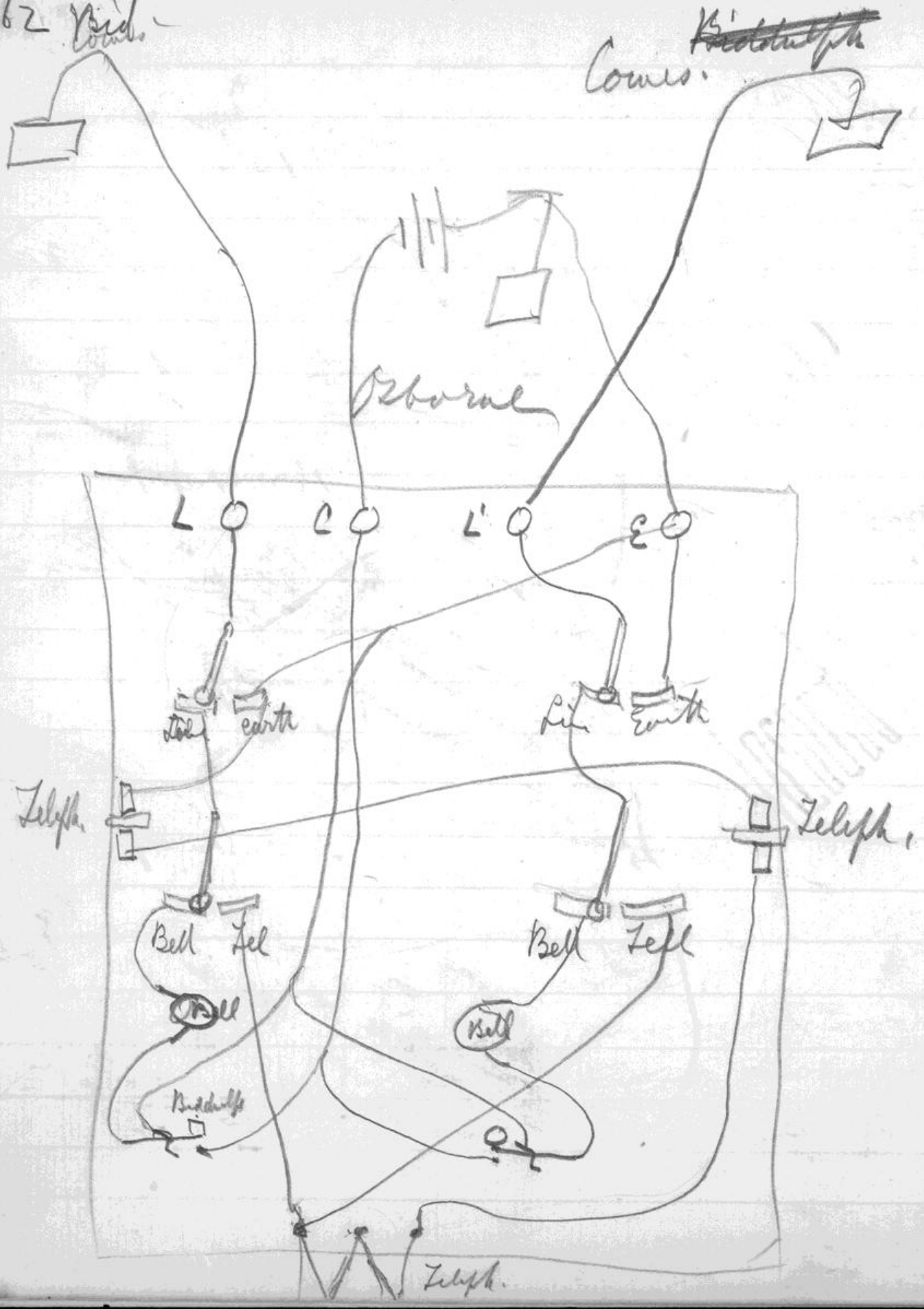
Increase of prim. cur. —— Sec. curs. of same kind
Decrease —— —— opp. "

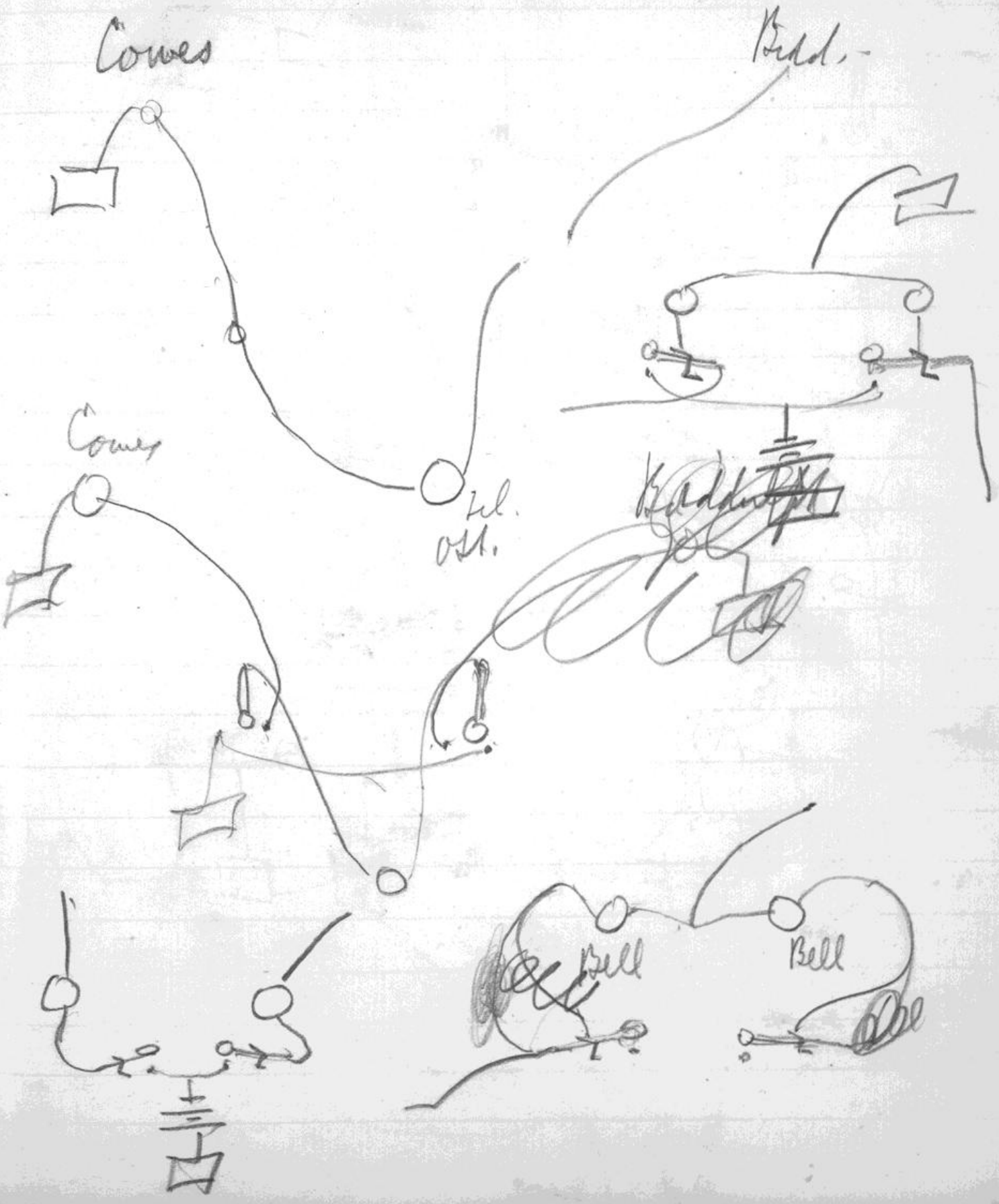
Hence in either case the shape of an electrical undulation is changed but in an opposite way.

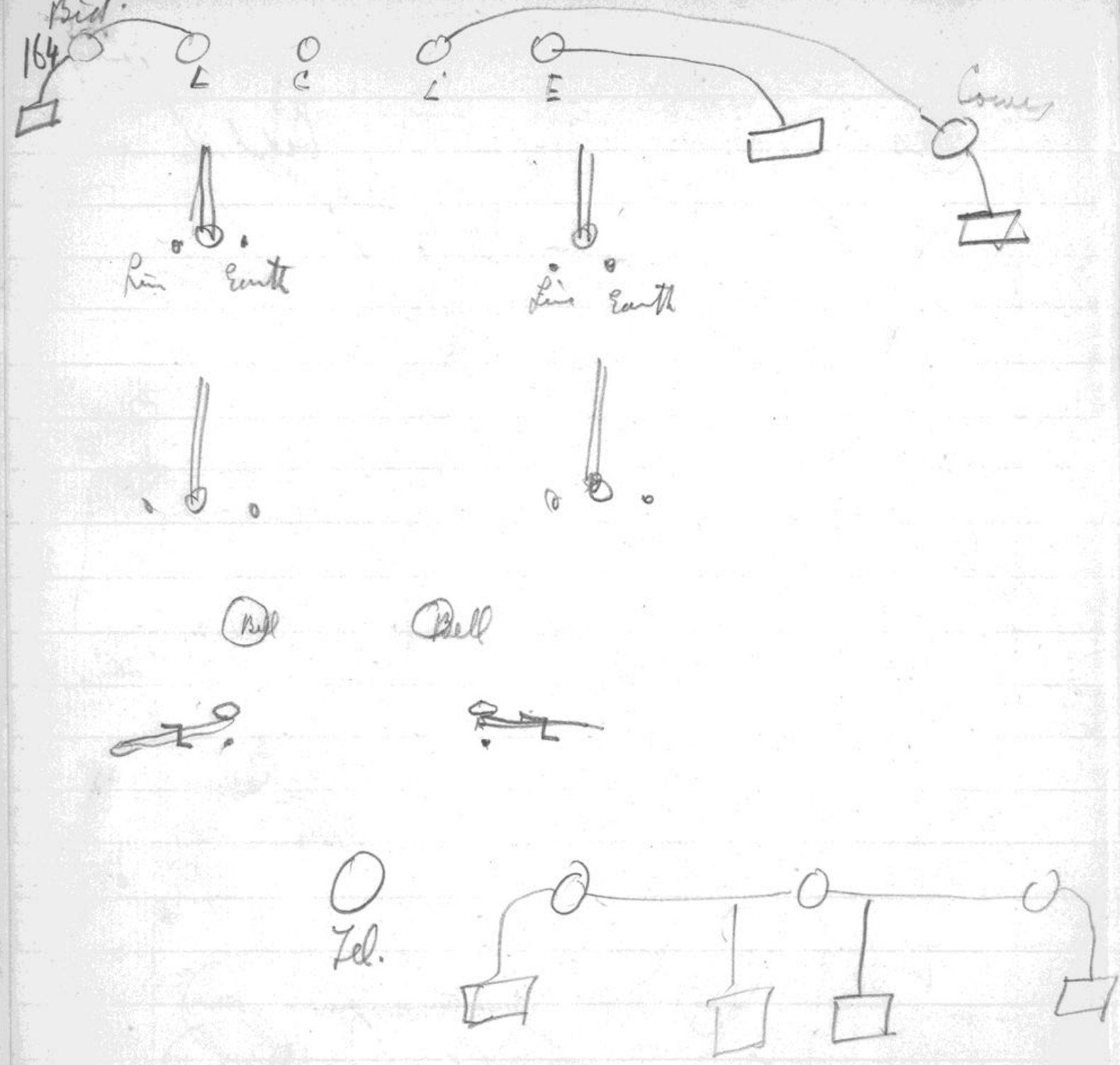
By passing current first through coil of one kind and then through other arrangement — the distorting effect of one will neutralize distorting effect of other. Make following arrangement. B Arrangement B forms a corrector for distortions of A.

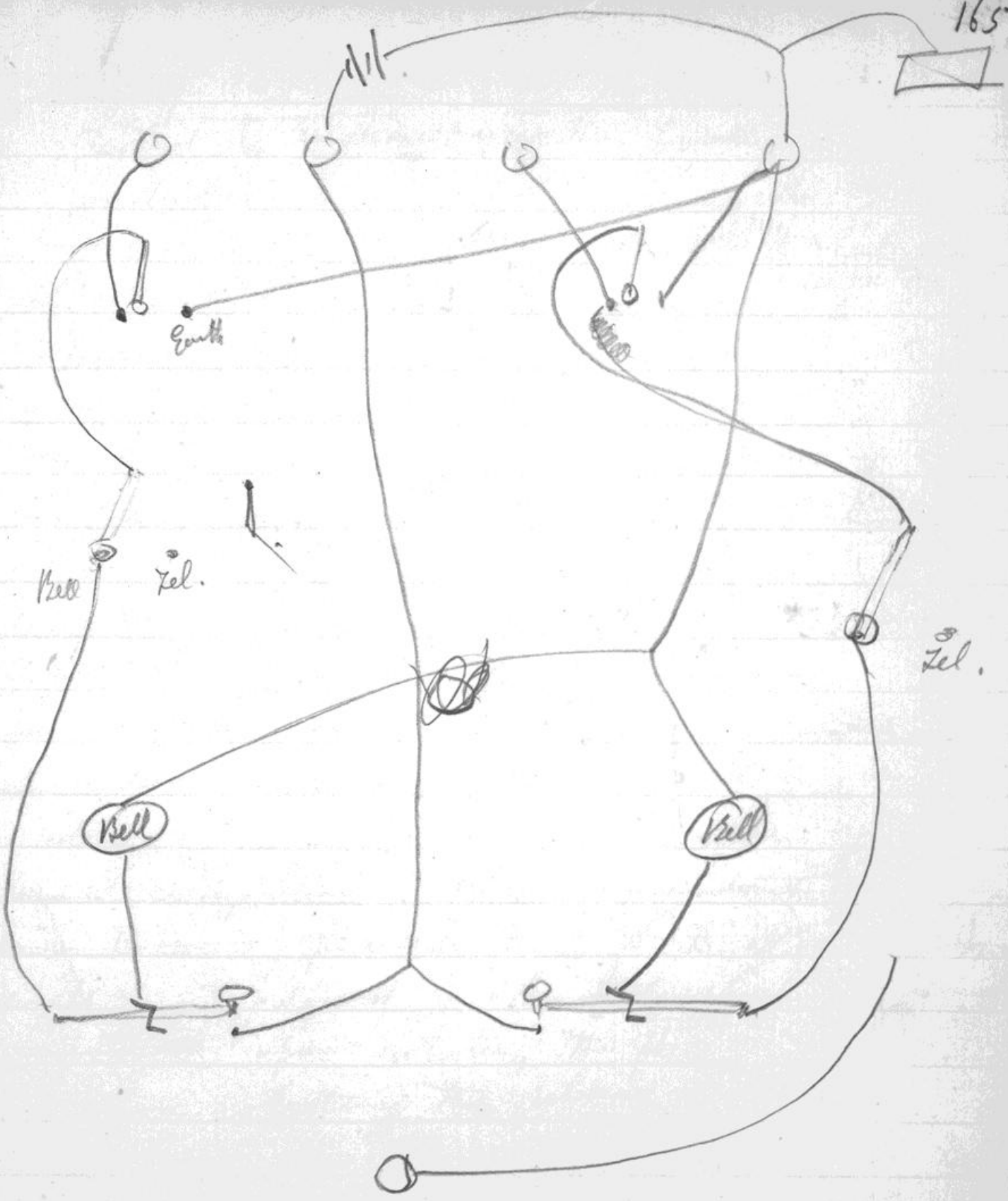



Primary
Secondary
Resultant
Primary
Secondary


Osborne
L
C
L'
E
earth
earth
Telegph.
Telegph.
Telegph.
Bell
Tel
Bell
Tel
Bell
Bell
Telegph.


Cowes
Bdd.
Cowes
Zl.
Bell
Bell


Bird.
164
L
C
L'
E
Line
Earth
Line
Earth
Bell
Bell
Tel.

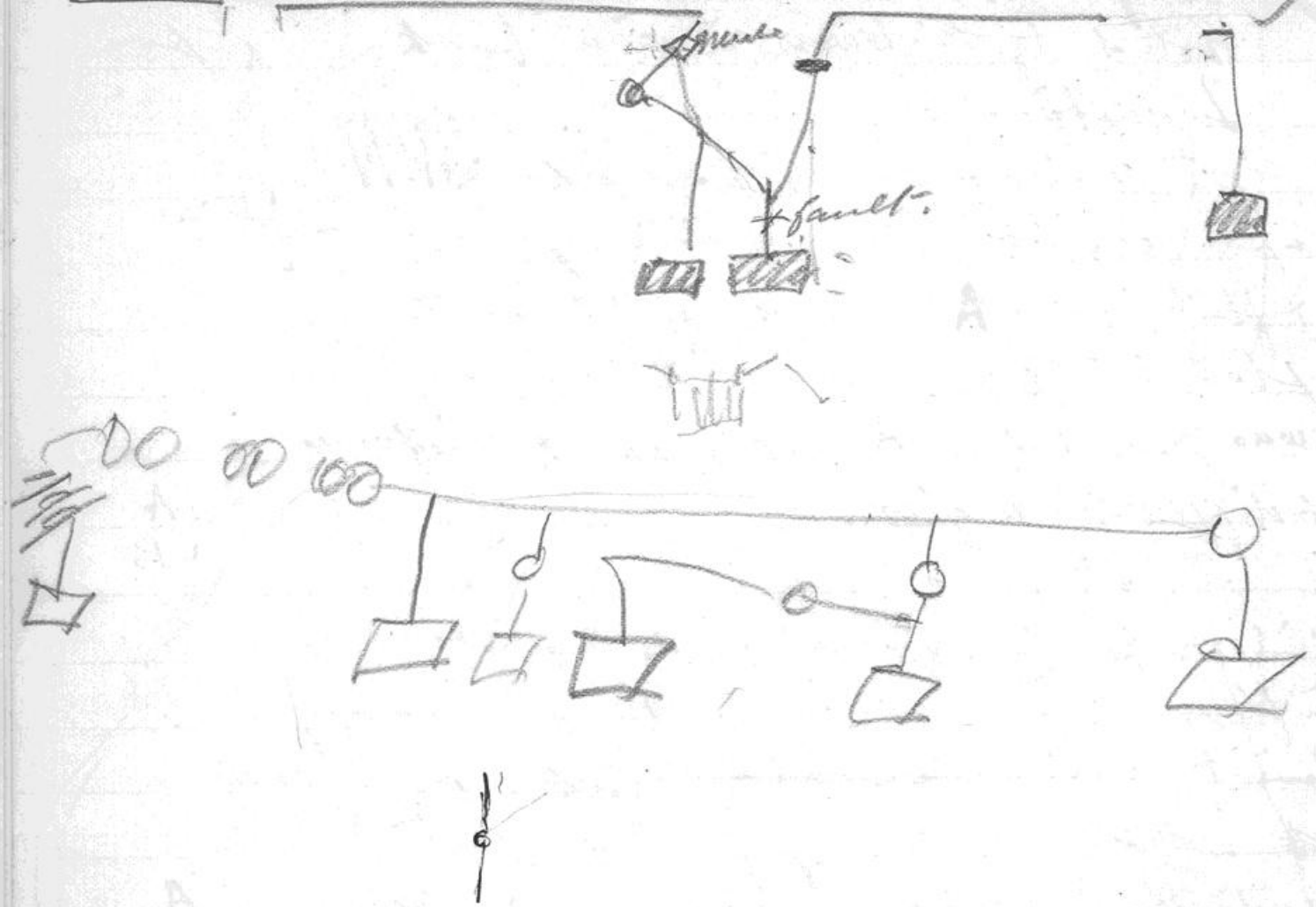

Earth
Bell
Tel.
Tel.
Bell
Bell

166
Swilly

Cowes

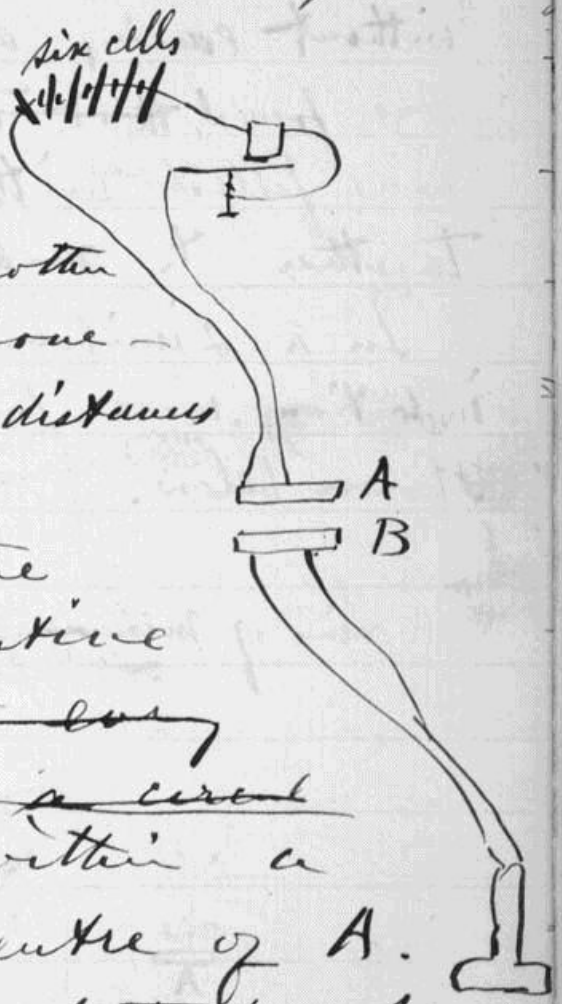
Osborne

Cottage



Jan. 29th 1878 — Continued experiments noted by W. Warner in other book — upon Induction.

A rheotome was arranged upon circuit with a battery of six cells, a flat coil A and another flat coil B connected with telephone — was presented to A at different distances & different angles.



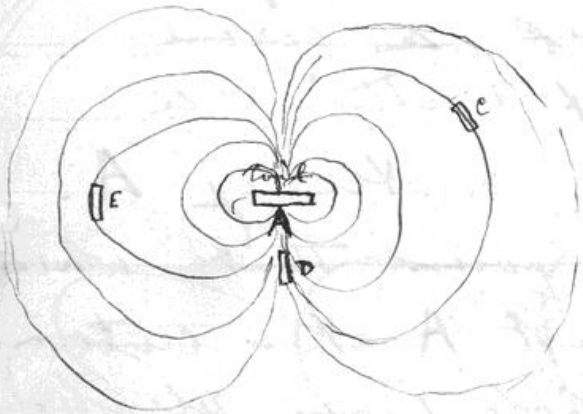
It was found that the coil A exercised a sensible inductive influence upon coil B ~~at every point within a circle~~ at every point within a radius of 13 inches from the centre of A. ~~And at every point it was found that when coil B was presented to coil A at a certain angle no sound was audible from telephone, & upon rotating the pl~~

Upon rotating the plane of the coil around a vertical axis it was found that at every point there were two positions where no induction was manifest & two positions at right angles & the first where maximum effects were obtained.

Upon marking upon paper the various positions ~~of coil B when in~~ that coil B could assume without causing sound from the Telephone it was found ~~that the coil~~ as the when the paper was filled with marks that the lines blended together to make a geometrical figure.

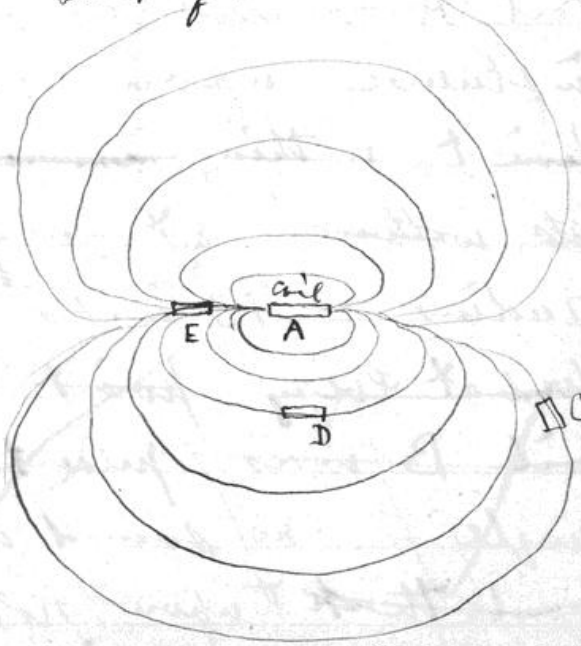
In a similar manner ~~the~~ the lines of maximum induction were formed. These figures are shown below.

Lines of minimum induction

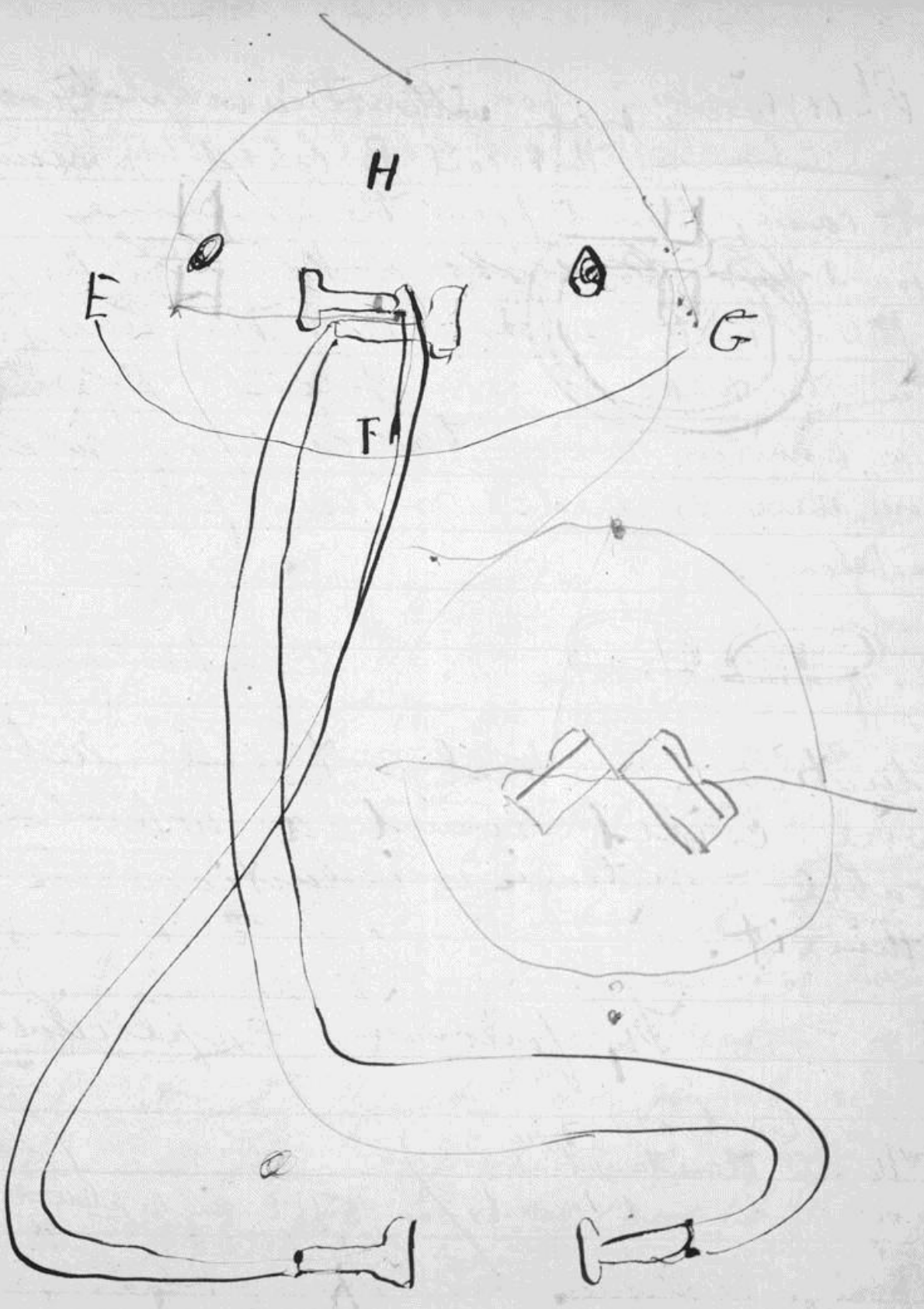


Coil B may be placed at any point (C D E &c) with its plane tangential to the lines & no induced currents are manifest in it — no sound proceeds from a telephone in circuit with it.

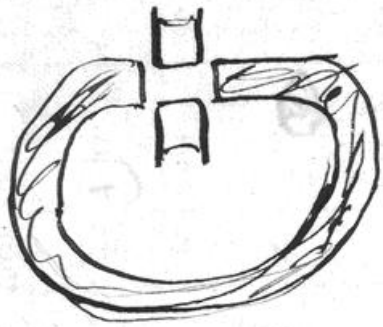
Lines of maximum Induction

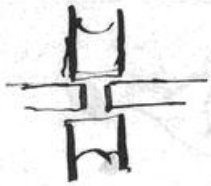


Coil B may be placed at any point (C D E &c) with its plane tangential to the lines and the maximum inductive effect is produced in coil B that is the maximum sound obtained from telephone in circuit with coil B is obtained when the plane of the coil is tangential to these lines.


H
E
G
F

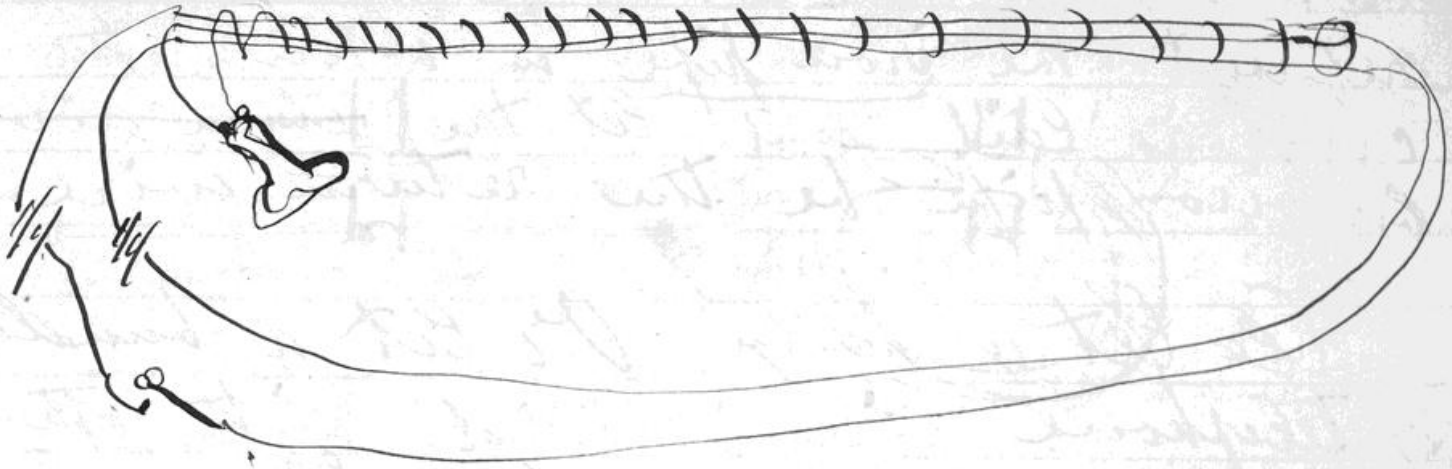
Feb. 18th 1878 Telephone without iron plate





Induction. Will not one return wire coiled round a whole cable ... neutralize induction for all within it.

Try following experiment.



Taking section of cable.

Although a is the point where outside winding (c) the neutralizes current in wire a. ~~Still although~~ Why ~~should~~ should not wire b be as much affected by (c) as (a) is.

Although b is further from c ~~than~~ ~~double~~ from that part of c marked d than a is (the effect of d upon b being therefore weaker than its effect upon a) — still it is just as much nearer to e — the effect of e should therefore be as much stronger upon (b) as d is weaker and thus the resultant neutralizing action of the whole wire e upon b be the same as upon a.

If this is the case. Let ~~B~~ C represent the iron pipe in which the cable is laid and let the ~~return wire~~ ~~be~~ iron pipe be the return wire.

~~Or Let a~~ Or let a bundle of telephone wires be laid with other wires in an underground cable and let the telephone wires ~~have~~ have a return wire coiled round them.

Thus:

It is better however where secrecy is required to have two wires for each telephone circuit.

If a number of wires have a common return wire — one telephonic circuit will repeat into another by leakage & by induction

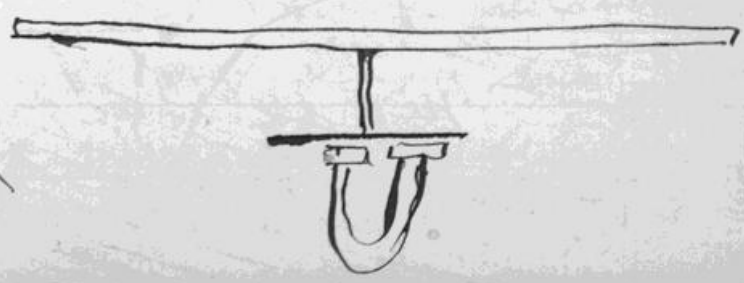
Of course however the faint echoes of neighbouring telephone wires would not prove so annoying as the clicking of the Morse Instruments and it might be a matter of

economy to have a single return wire.

Reinforcement of Telephone.

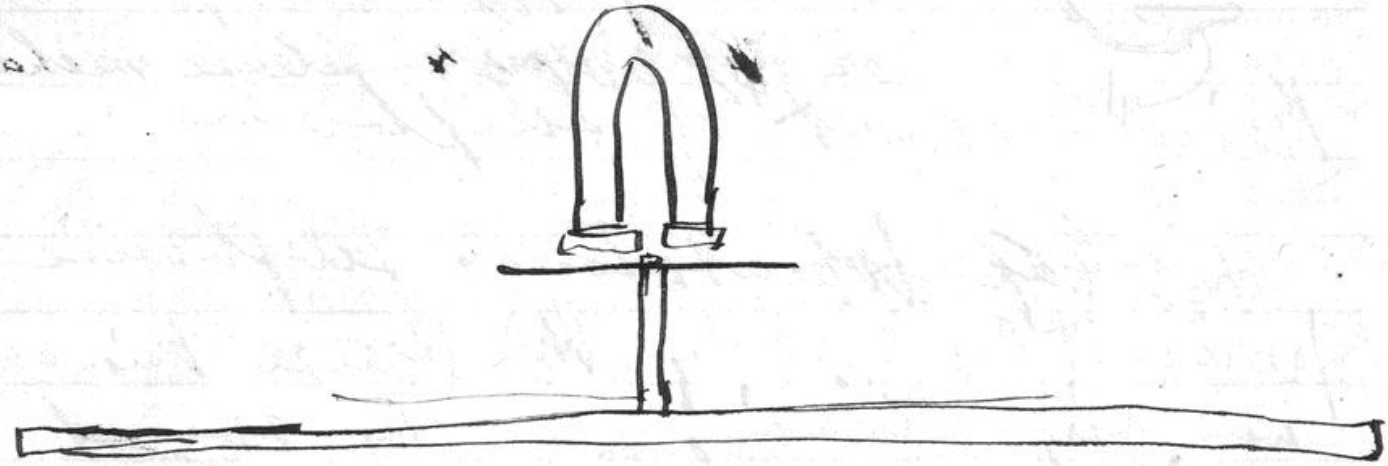
Cap Wheatstone's Telephonic experiment made by Mr. Preece this evening was very striking. No sound was audible from the wooden rod — until a large board was placed upon it.

Why should not same effect be produced in Telephone. Instead of attaching the plate of Teleph. to a fixed sounding board which impedes the vibration of the disk — attach to it a vertical style carrying a light piece of wood or metal or card-board of very large area as

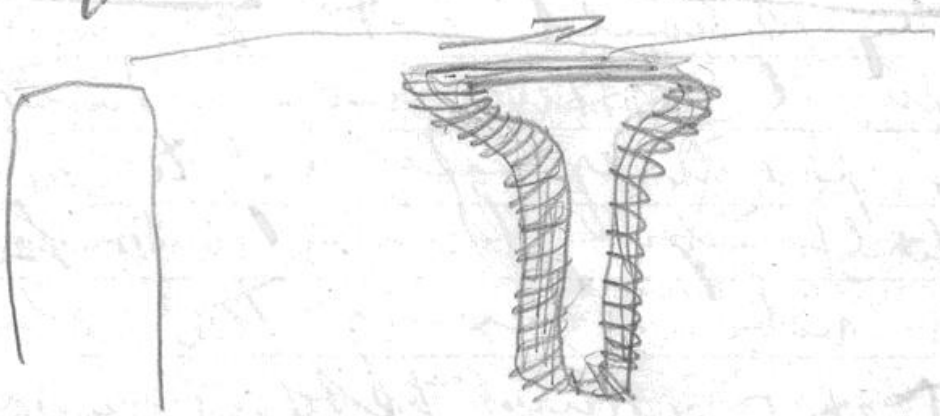


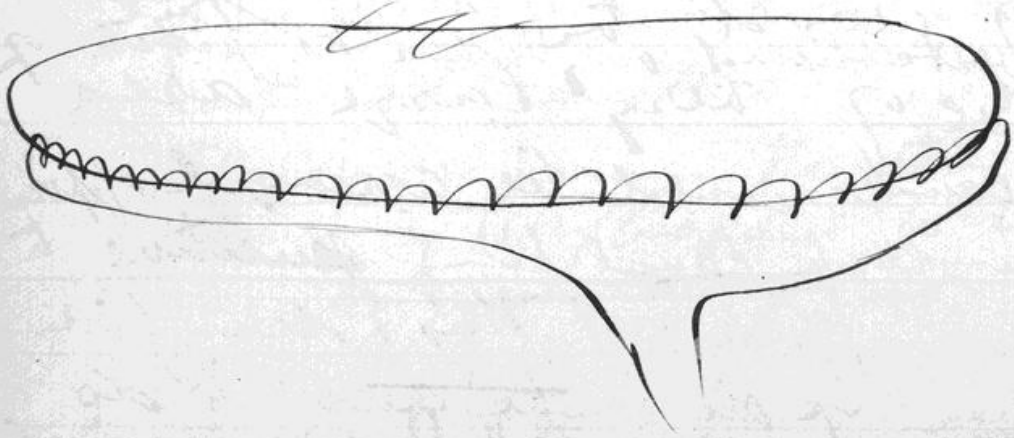
Over

Or let Telephone be held downward and would be below.

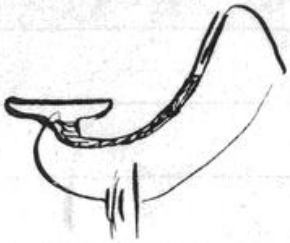


Feb. 6th 1878





Feb. 7th 1878



Let mercury ~~[illegible]~~ close or open local circ. or ~~[illegible]~~ release mechanism

Feb. 9th 1878 —

Let upward action of plate A open valve. Vibration of valve will force up air or liquid & lift piston — or make a local circuit —

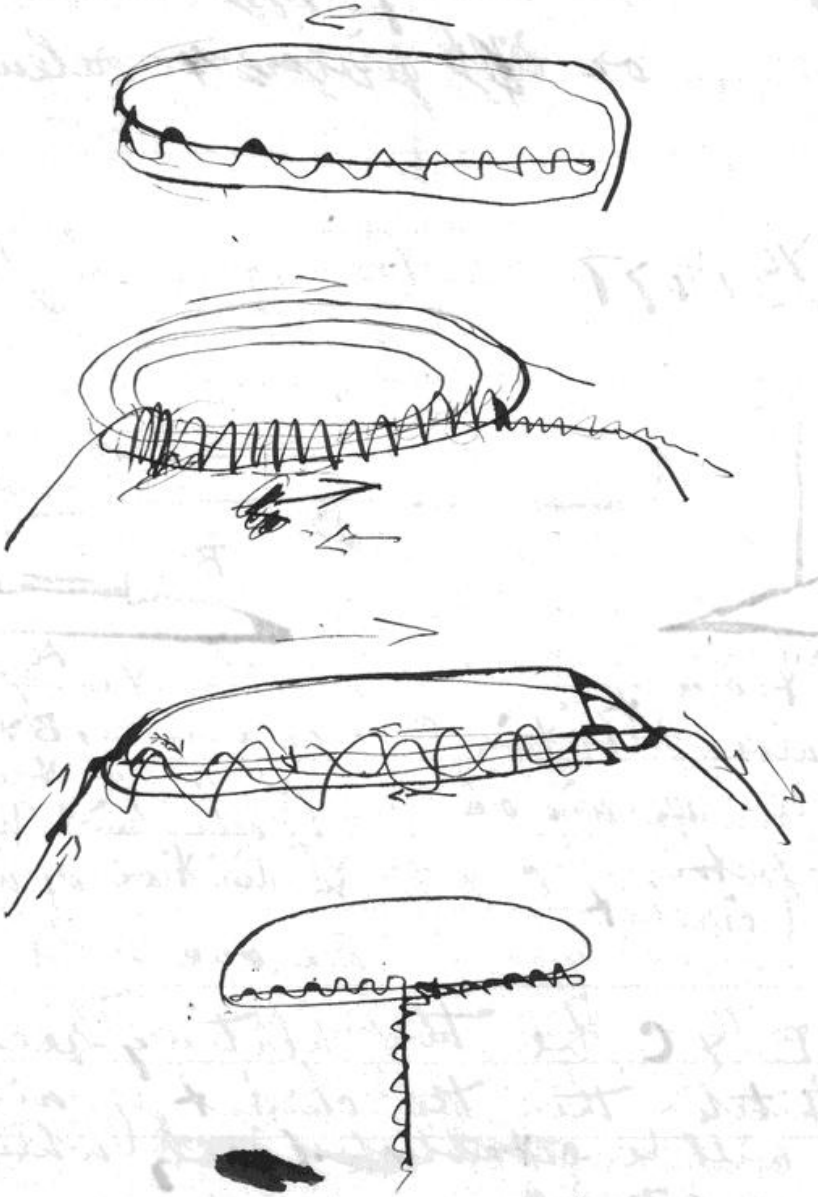
Vibration of disk A will cause valves B & C to open alternately and a continuous current of air will pass through pipe in direction of arrow-head.

Let B & C be two beating reeds tuned to the same pitch — then the current of air a liquid in the pipe will be established only when the pitch of A is the same as B & C.

A number of canals could be arranged opposite a ~~[illegible]~~ plate — each canal being sensitive to only one pitch. Work out this idea for multiple telegraphy. If air can be made to do instead of liquid ~~[illegible]~~ no external shaking will

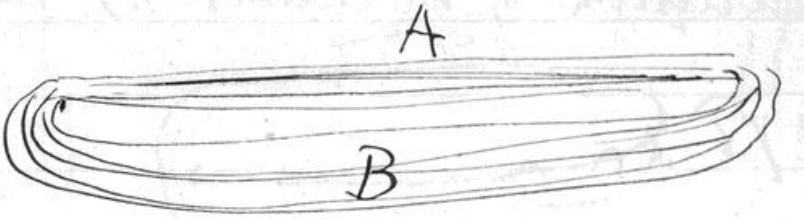
176

affect it

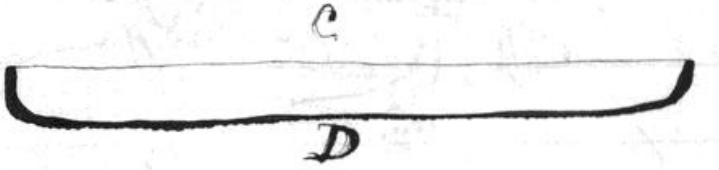


Feb. 15. 92/97

Let portion of multiplex A be of fine wire and the other portion B of thick wire



Let C & D be section of a single coil

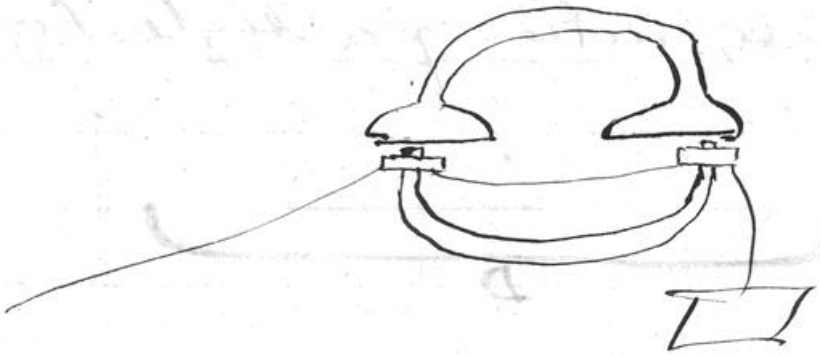


How would such an arrangement be affected by induction? If wires C & D were even very close together it seems to me that the difference in the resistance of C & D will be so great that the currents induced in the one will not quite neutralize those induced in the other and the arrangement will be affected by induction in the same manner as if this arrangement was a straight wire of a resistance equal to the difference between the resistance of C & D.

Would the currents induced in C or D be the stronger? Would not such an arrangement be sensitive to distant electrical currents when connected with a telephone.

For instance - Earth - currents. It seems to me that not only could earth currents be detected but the direction of the current as well

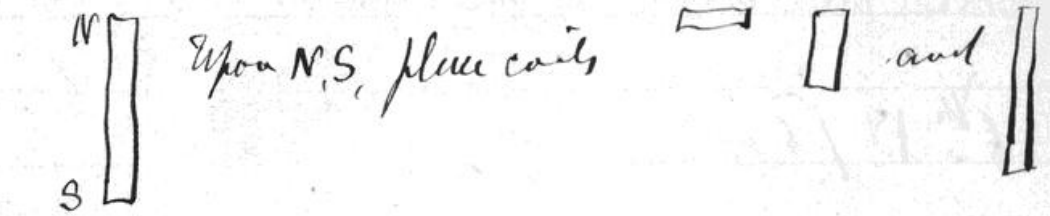
Feb. 16th. 1878.



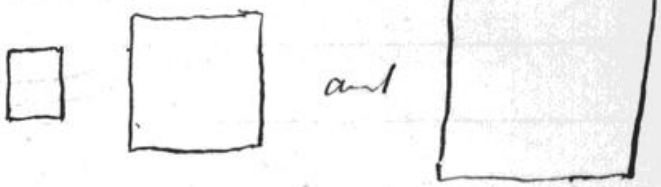
Feb. 18th 1878 Experiments made Feb 16th (Saturday) prove conclusively the superiority of soft iron over steel for a plate. These experiments also seem to indicate that surface is of more importance than mass in the plate.

Try Reduced iron. How would a thin sheet of iron deposited electrolytically upon a sheet of glass. Glass is splendidly suited for a diaphragm & is cleaner than almost anything else.

Test Telephone through resistance & Shunt.
& take deflection of galvanometer.



and take deflect. through great & small Resist and through Shunt. Use thick & fine wire.

Then take diaphragms.  and

Rectangular so that you can measure the area.

~~Take Place &c. Then use four diaphs~~

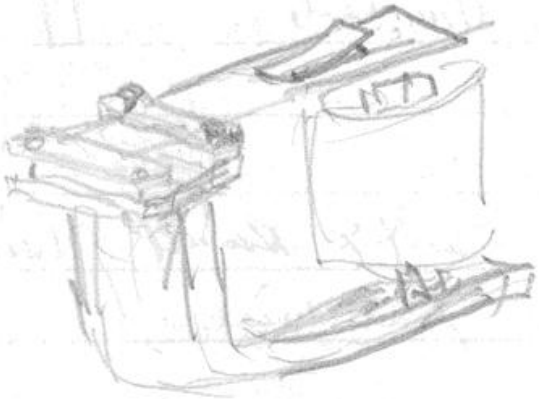
Place 1 2 3 & 4 diaphragms above one another, and remove all suddenly & note deflection.

~~Place~~ & Place diaphragm on pole. remove suddenly & note deflection. ~~Then place~~ call deflection A. Then place on pole a piece of paper same thickness as diaphragm & on the paper put diaphragm. Remove suddenly. Call deflection B. Then place two diaphragms upon pole remove both suddenly. Call deflection C.

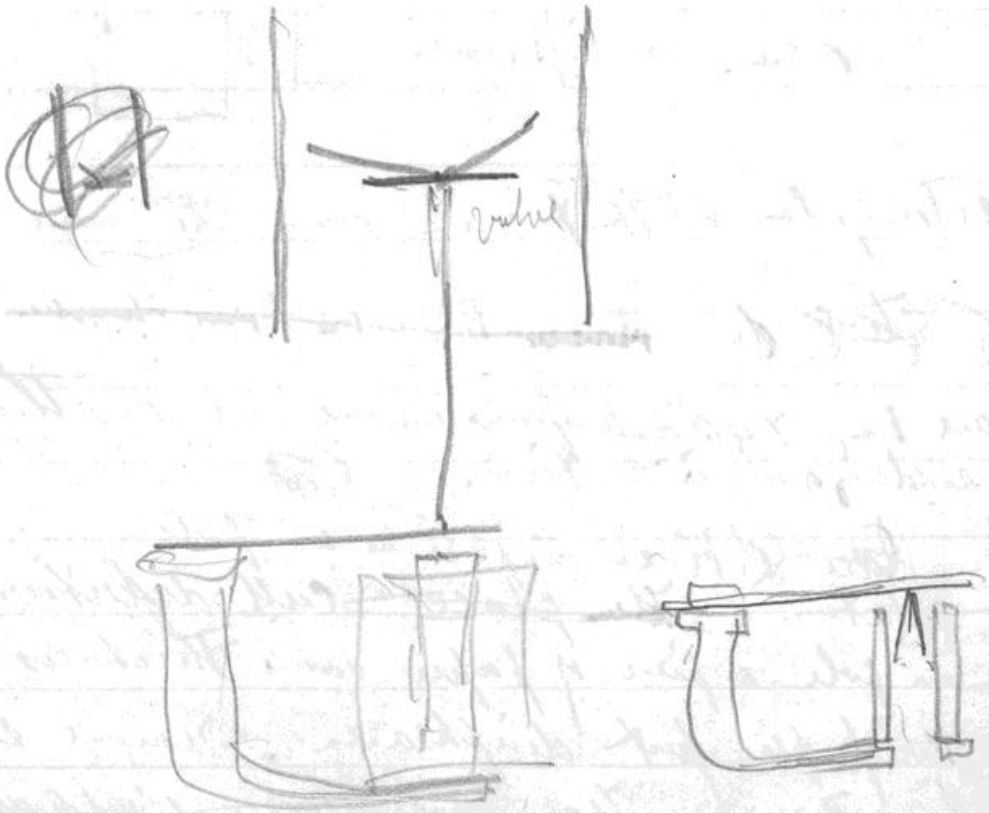
Query Will $C = A + B$ (?)

180

Feb. 20th, 1878—

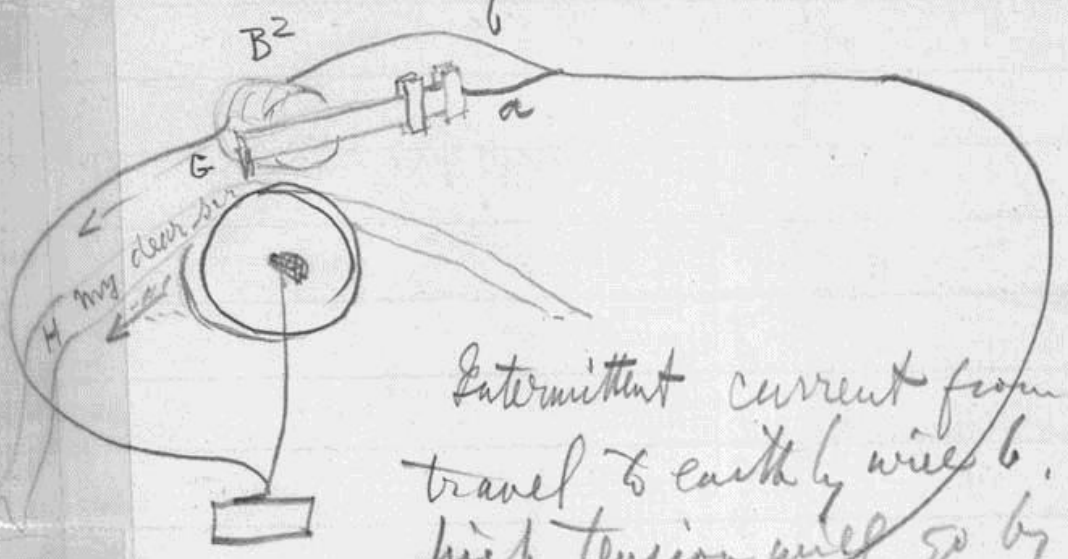


Place value in armature.

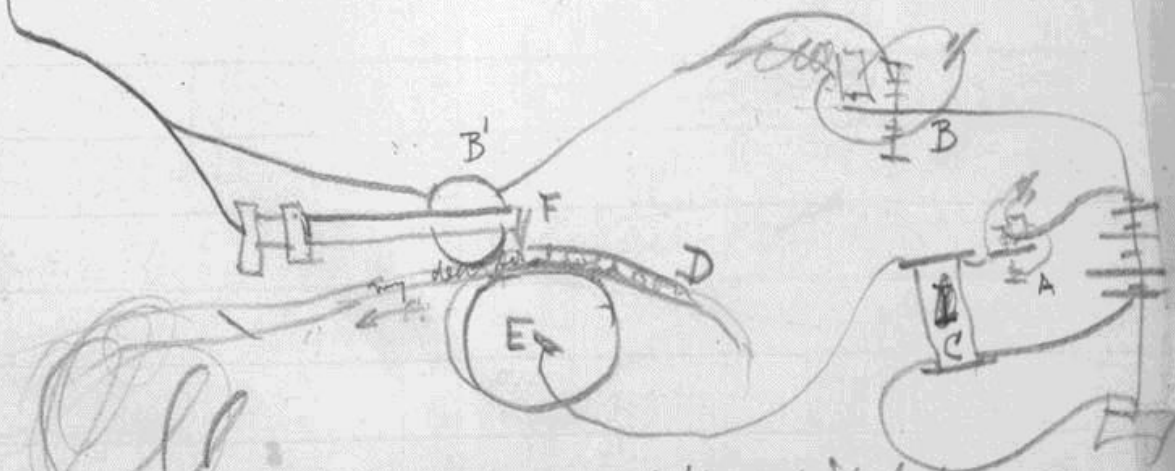


March 4th

New Autograph.



Intermittent current from volt. batt. with. travel to earth by wire b. Induced curr. of high tension will go by wire a + leap through insulated paper

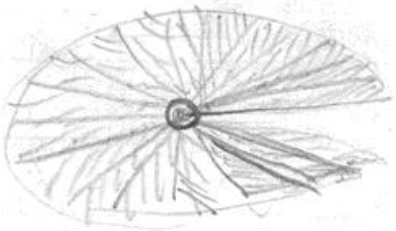


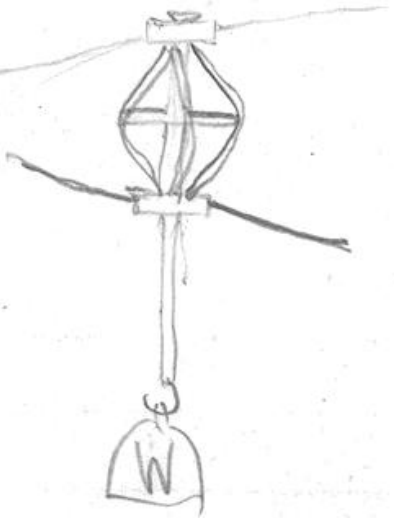
A + B two Rheotomes A having very much higher pitch than B. ~~Induction coil~~ B' + B2 Electro-magnets with reeds tuned to pitch of B. C Induction Coil. D paper with pencil writing upon it. Induced current will leap from cylinder E through that portion of plumbago which happens to be under point F. and will transmit line line + make mark upon insulated paper H - such a facsimile of writing. Coils B' + B2 should possess considerable resistance.

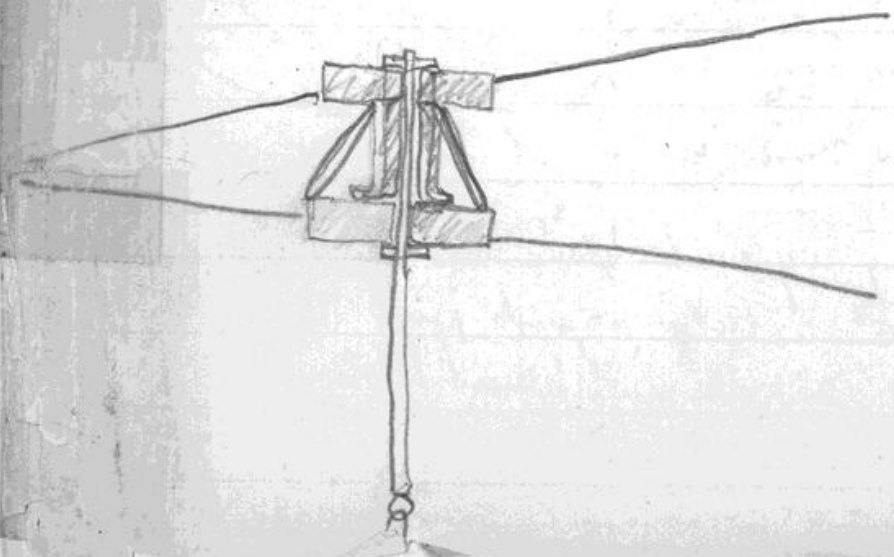
182

March 7th. Aeronautics.

Make fan wheel of feathers.







March 8th - 04 | 5

Let resist. of air for a certain mass to X — to downward surface by R

Enlarge this surface with surface A W ^

R Resist. increases with surface of moving body & with square of velocity for slow velocities & at higher rate for greater velocities.

If this is so — would not doubling the velocity of rotation — quadruple the lifting power of machine.

The obstacle to the motion of machine is the weight. Weight tends to move it down & is opposed by resistance of air. Resistance depends upon horizontal surface of machine & upon velocity of rotation.

In order to be supported W = R

(In order to rise R must be greater than W.)

So far as lifting power is concerned velocity rotation more import — than surface. So far as safety is concerned surface is of great importance as preventing too rapid descent in case of accident. Most of the enormous resistance to downward motion is slight resist. as possible to motions in other directions.

Use liquid Carbonic acid as motive power or if obtainable liquid air or Oxygen. In latter case the escape air could support flame which could be utilized to heat confined gas or liquid — or to support life of aeronauts if machine could be made large enough.

If machine is to be directed by electric wire — Heat carbon in the gas & thus expand it.

March 16th. Current passed through primary coils of coil produces no effect in secondary coil after starting — while it is of uniform strength — ~~but if it varies the moment it varies~~ a the moment it changes in intensity — secondary currents are produced.

Could not secondary currents be utilized as a means of keeping the primary current of uniform strength — or of keeping mechanism in motion at a uniform rate.

When primary current increases galv. in sec. circ - defl. one way — & when it decreases — galv. defl. in oth. way

Could galv. not be made into a relay — and operate local circuit ~~& increase~~ so as to affect primary battery or regulate the mechanism whose motion affects primary circuit — when needle goes one way — operates local battery & causes mechanism to go more slowly & when it goes the other way causes mechanism to go more rapidly. Worth thinking of.

March 16th. In order to have apparatus that will stand wear without repair have circuit unbroken (if possible) and ~~have all contacts~~ use rubbing contacts.

Use no springs for they deteriorate with constant use. Simple contacts become dirty by use & thus become inefficient. Rubbing contacts become cleaner & more efficient by constt. use.

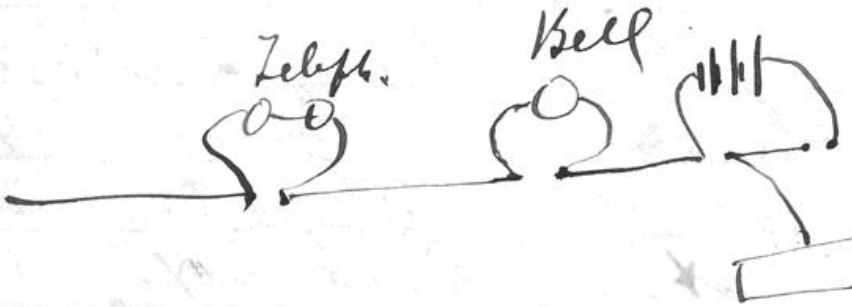


Fig 1

Use single stroke bell in preference to the continuall ringing bell.

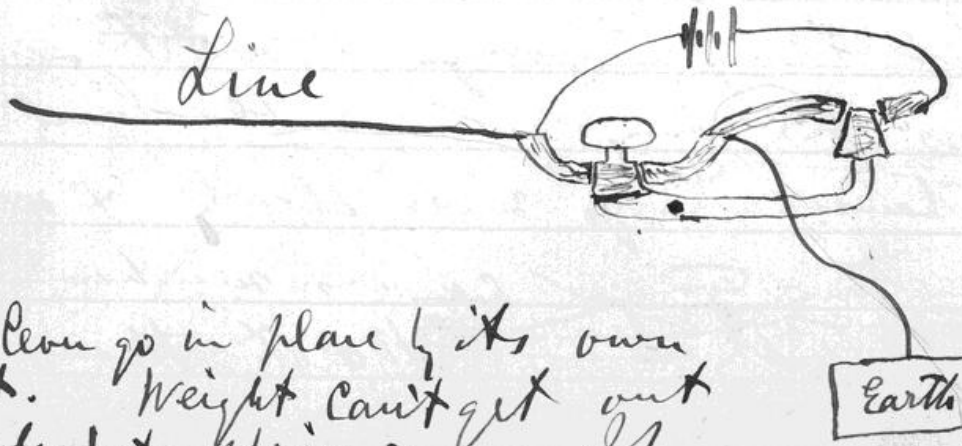


Fig 2

Let Cover go in place by its own weight. Weight can't get out of order but spring can. If pivot could be done away with it would be

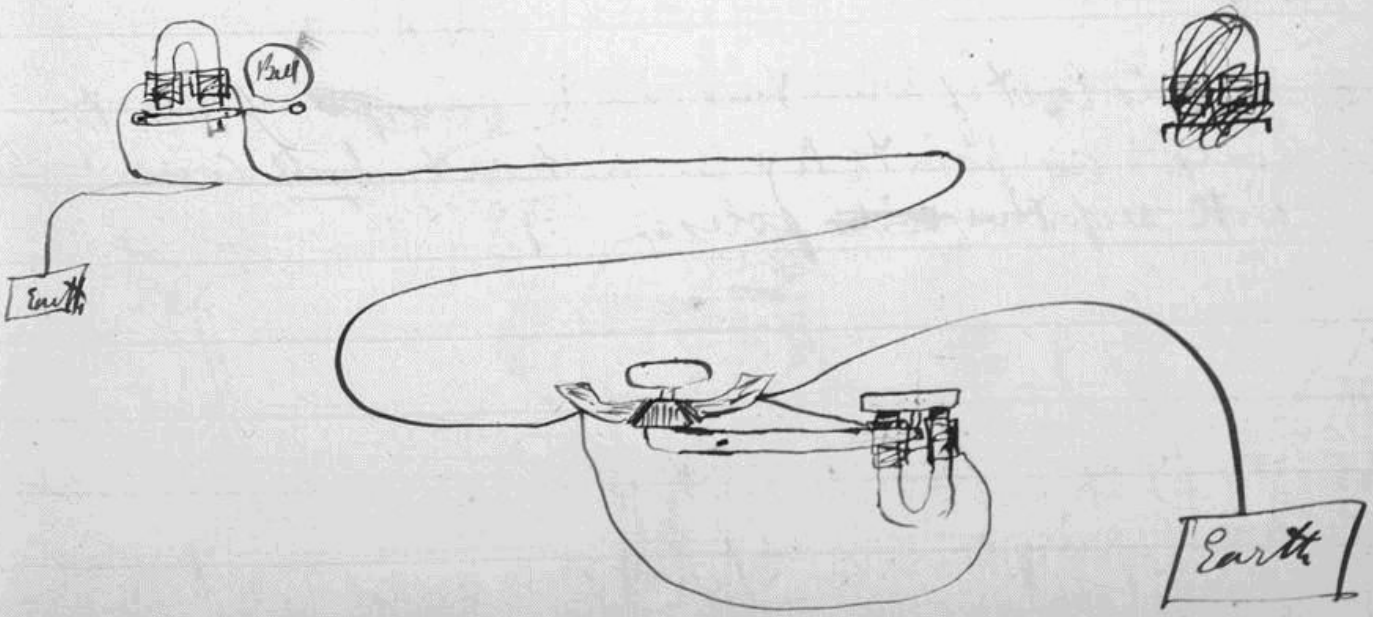
better — for a pivot if slender will become loose by the action of friction & gain lateral motion. No — no objection to pivot. ~~Principle should be~~

Principle should be: ——————

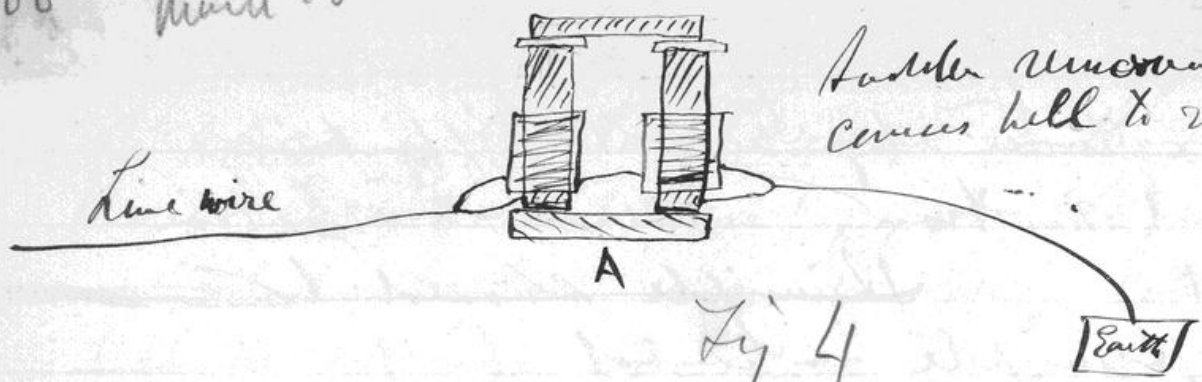
All the moveable parts should be of such a nature that use will improve their action. Pivots will become easier by use — friction contacts will become brighter by use.

If one could avoid breaking circuit at all — one element of depert would be gone. Magneto call preferable to battery call for this reason.

How is this?



188 March 16th



Another movement of armature causes bell to ring

Fig 4

Contact not frictional

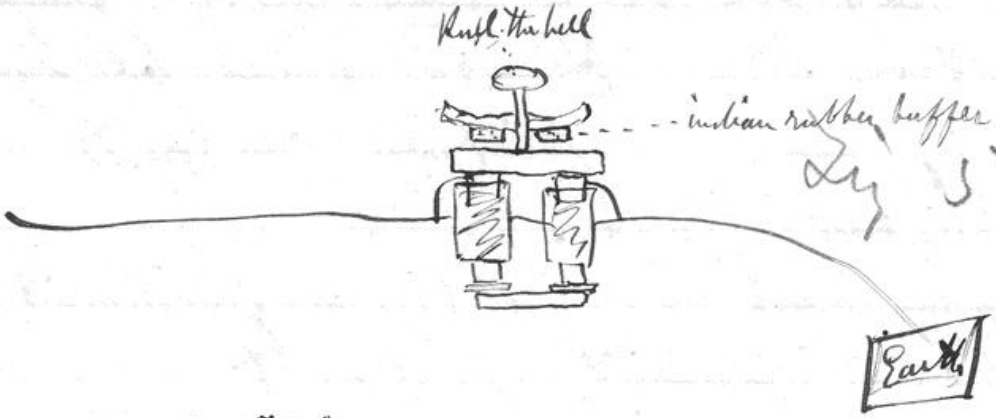


Fig 5

Or this

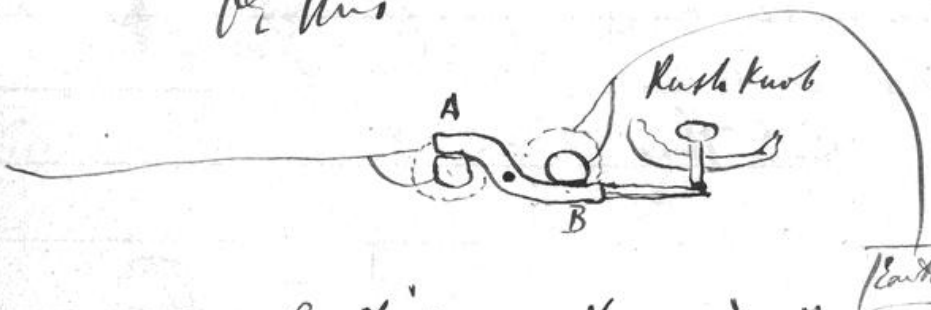


Fig 6

Not so good as last if armature is to ~~complete~~ short-circuit coils as points A & B might not both come into contact with respective ~~wire~~ poles.

March 16th.

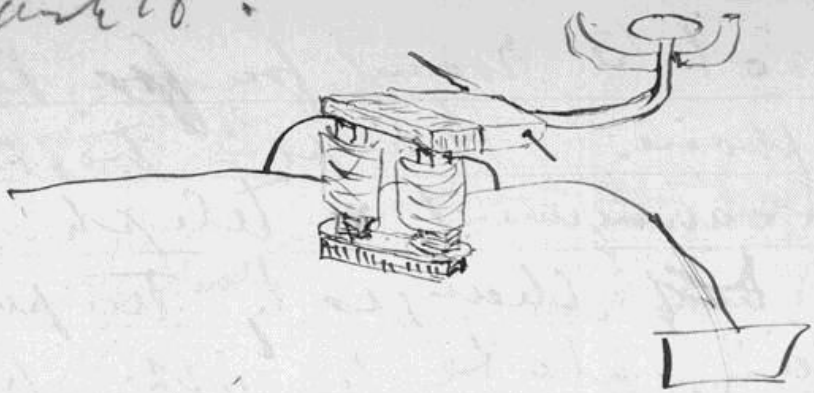
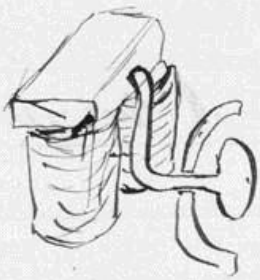
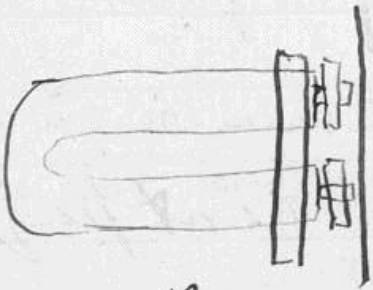


Fig 7



May showed not have permanent magnet to be used for Telephone, Bell, & call:

Modify this: ——



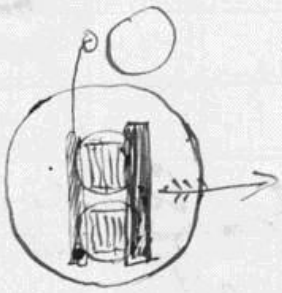


Fig 8

Perhaps portable.

Fig 11

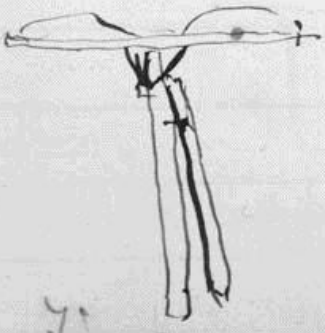


Fig 12

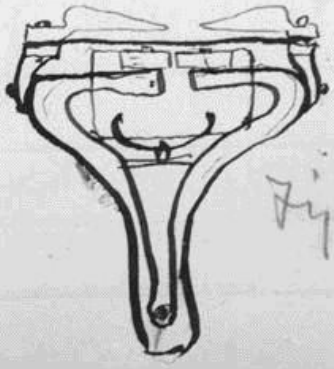


Fig 9

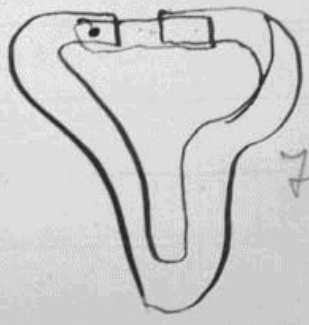


Fig 10

190 Mandell 16th

Would there not be room for Bell & all inside. telephone. Perhaps too heavy.

Actuing coil-arrangement & teleph. can be combined & ~~dont~~ changes by temperature avoided by fastening plate to upper part of telephone magnet.

May not compound magnet. like armored drawn

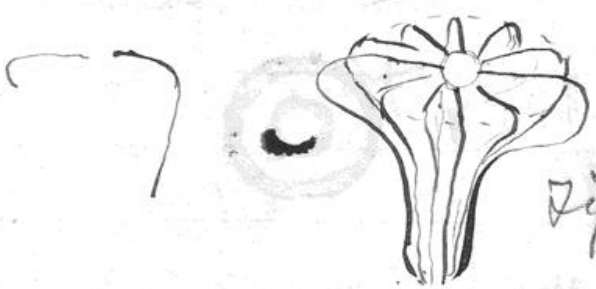
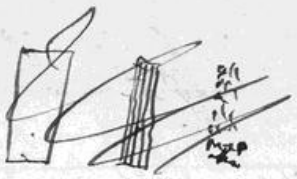
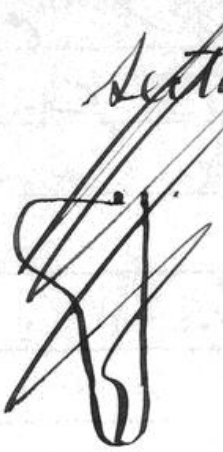


Fig 13

Continue this with Compound tubular magnet & idem & have coil as shown on next page



Section



Sectional view

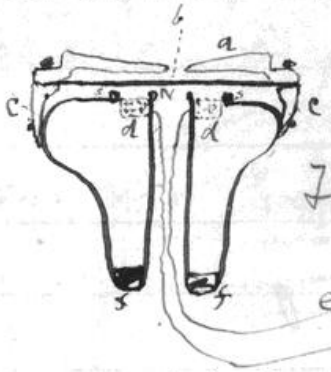


Fig 14

a mouthpiece
b plate.
c support for plate.
N.S. the two poles of mag.
d - coil
e - wires
f - wooden ring

Plan of top of magnet.

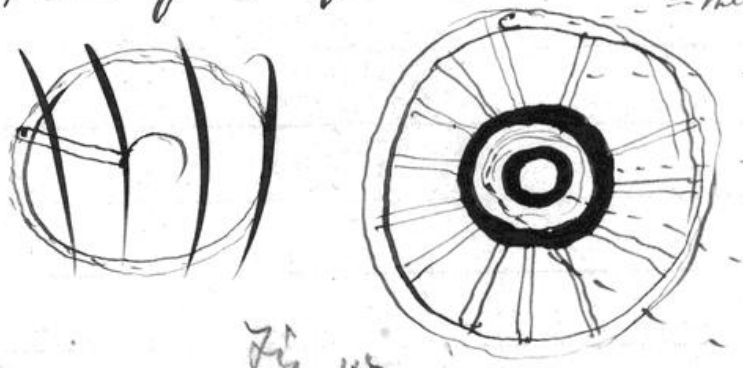
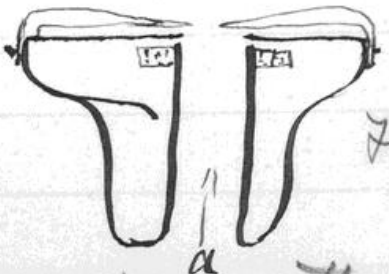


Fig. 15

c. Metal rim for support of plate.
---- one leg of permanent mag.
---- soft iron ring forming one pole of perm. mag.
---- Soft iron ring form. other pole
---- Coil of insulated wire.

Why not do without plate.

Section



Plan of magnet plate

Fig 16

Fig 17

Cover with wood or other material.

Turn instrument upside down and talk through a. Wire could be coiled round a as at c connect it into a tube, Fig 15.

Why not have another coil outside outer iron ring in Fig 15. a third coil inside inner ring. All that is necessary is that direction of current must be reversed in adjoining coils.

Why not a succession of iron rings & coils so

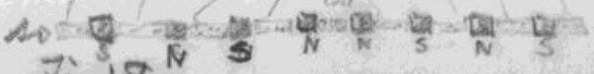
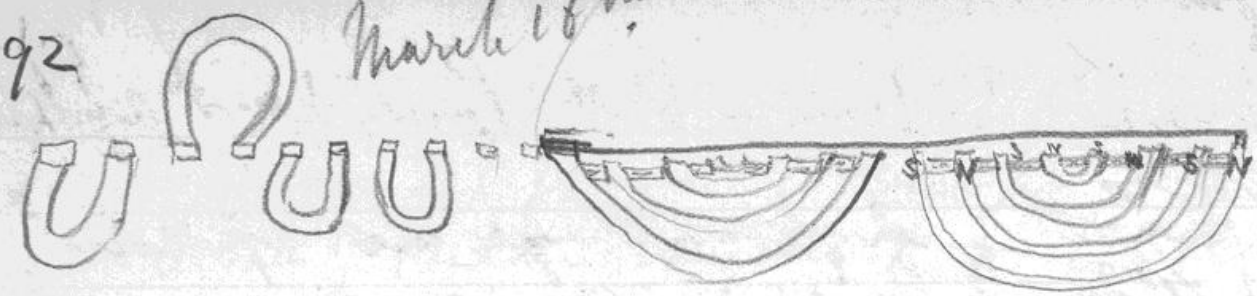
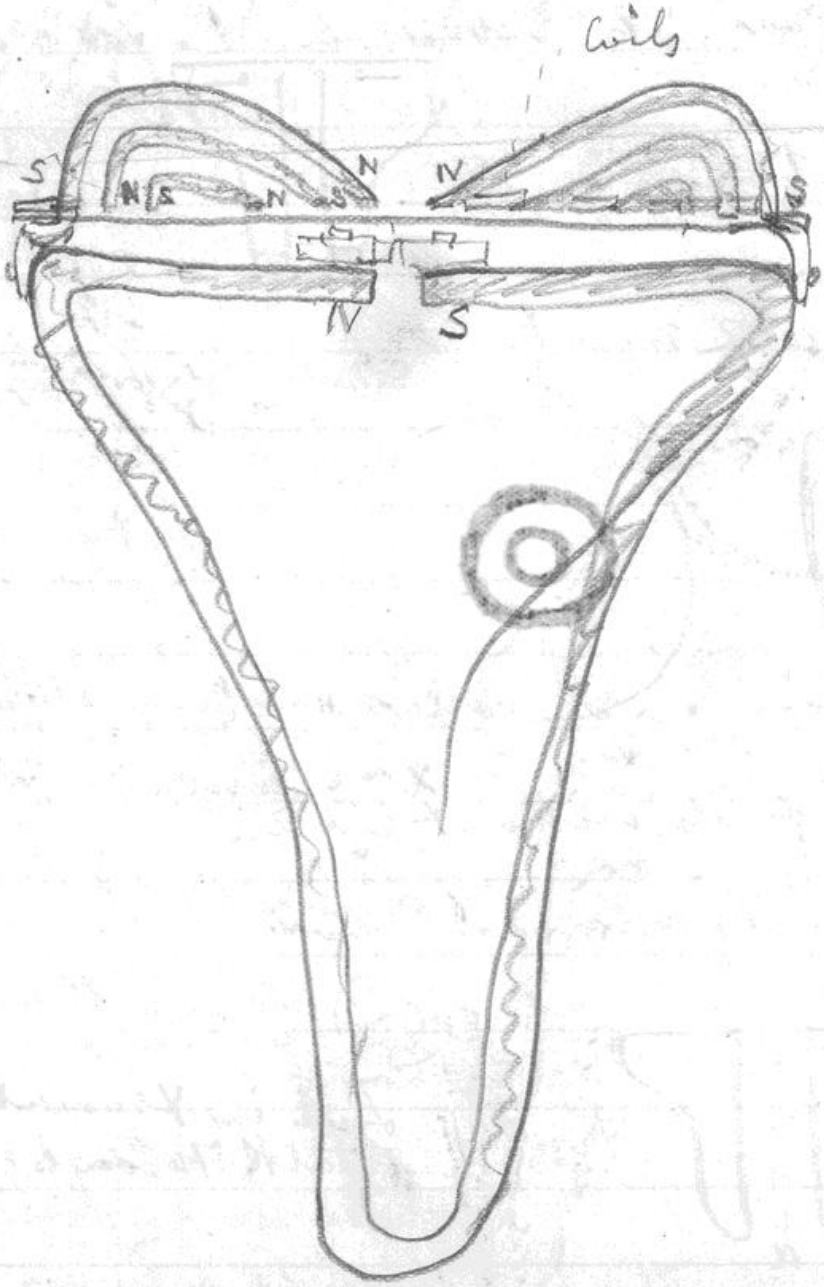


Fig 18

192 March 16th.



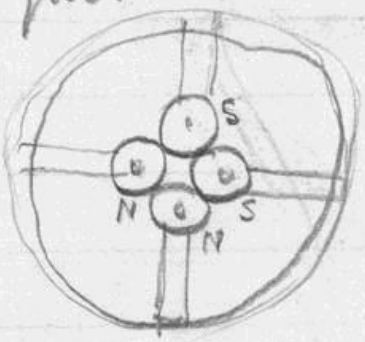


March 16th

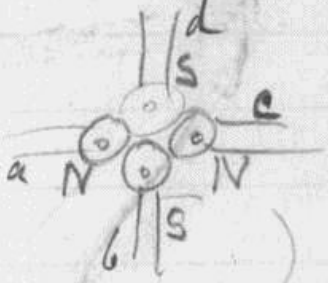
Mouth-piece too heavy – but Comm part splendid

Make magnet of telephone shape as speedily as possible. Perhaps try two telephone-shaped magnets forming a cross and four coils

Plan of top of magnet K.

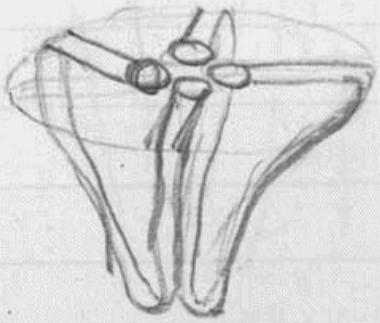


or



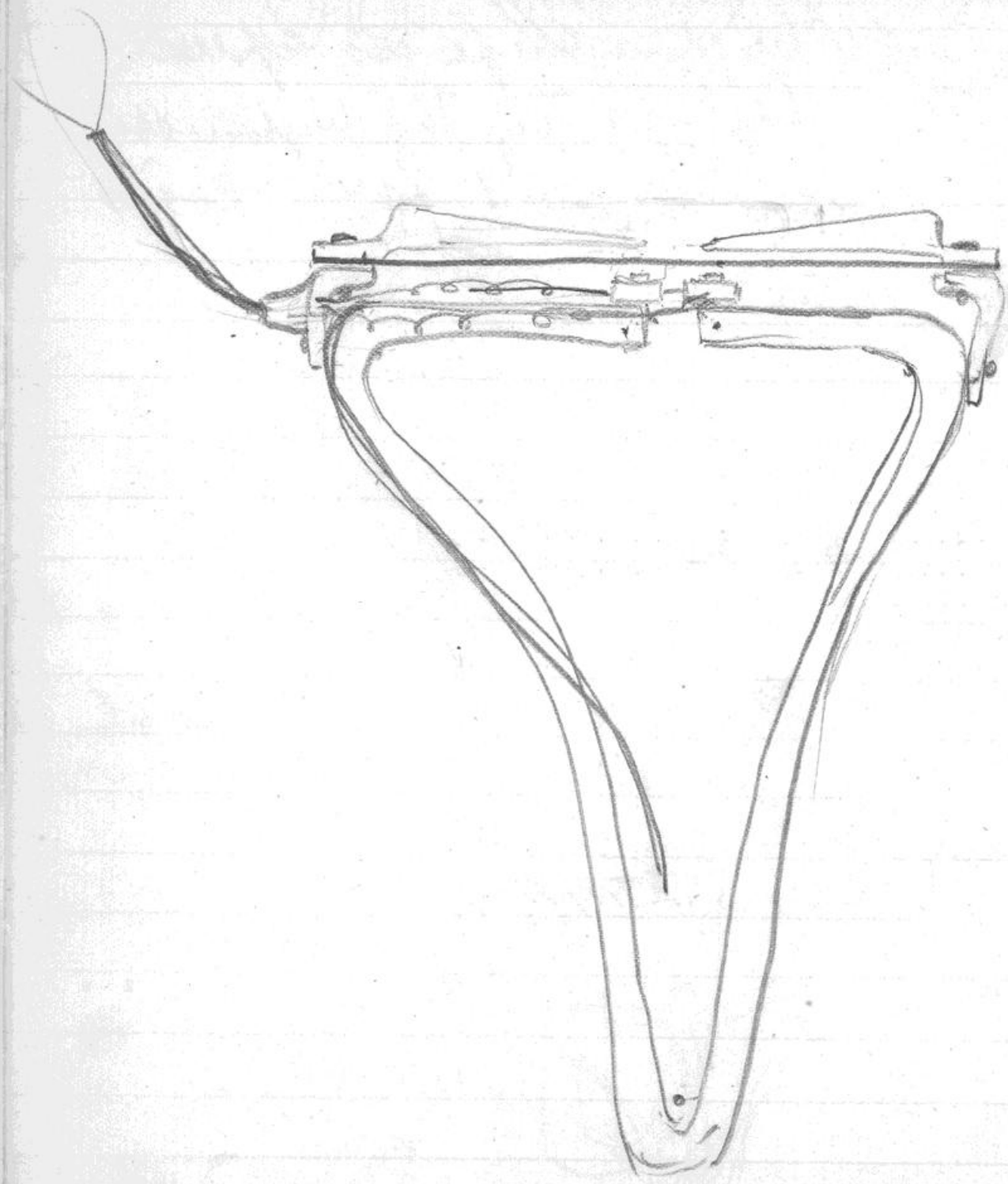
Opposite poles will approximate. Would need following arrangement: a & b would be poles of one mag. & c, d, those of other.

Sectional view



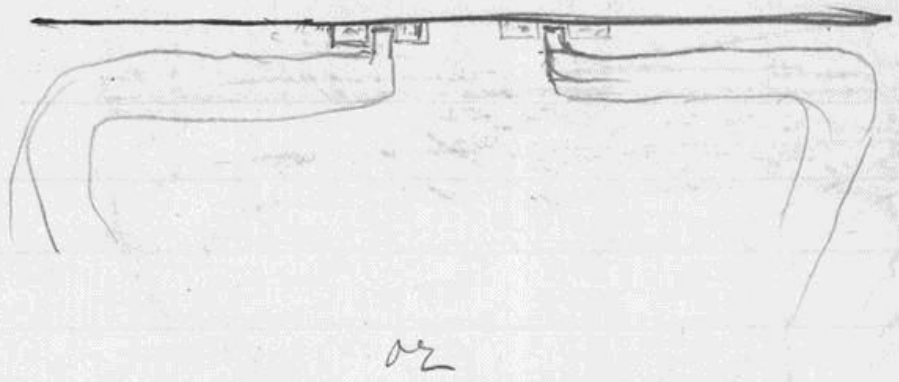
Awkward!

194 March 16th

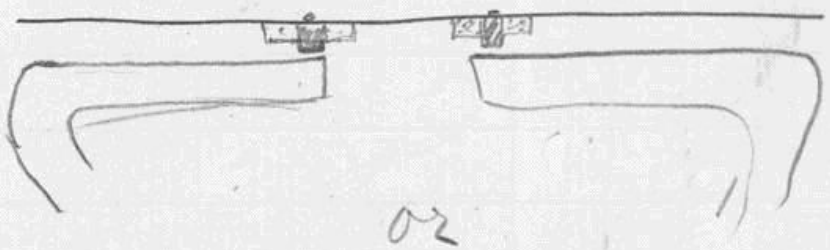


March 16th

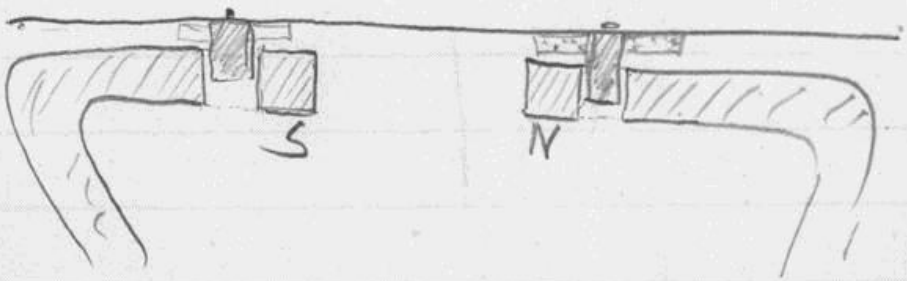
195~



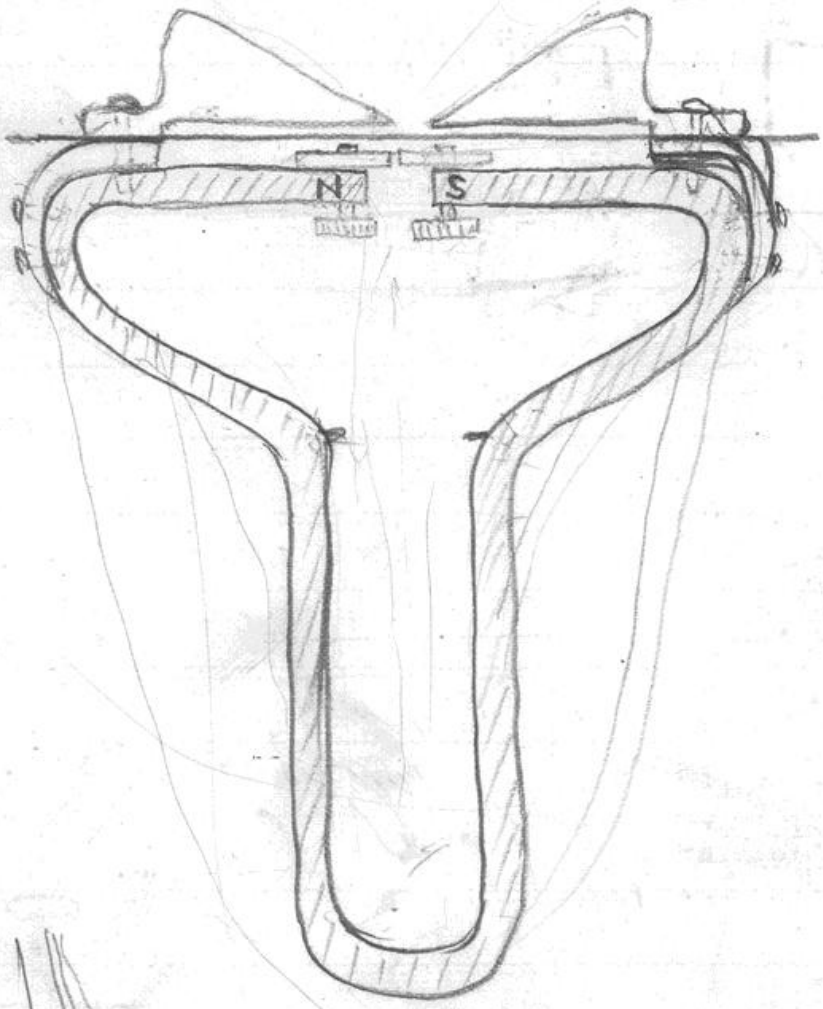
or

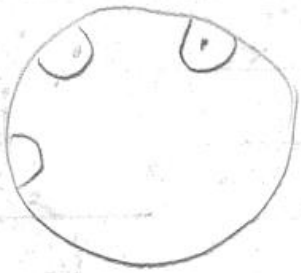


or

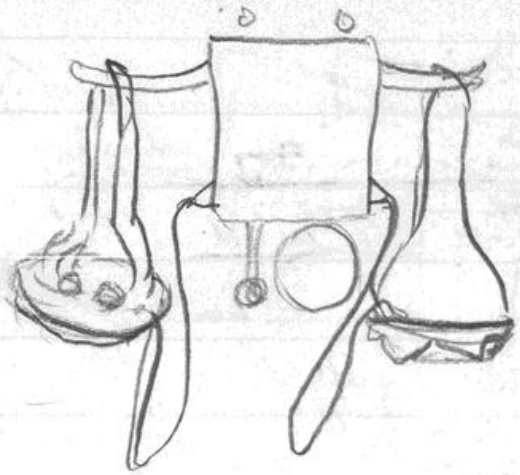


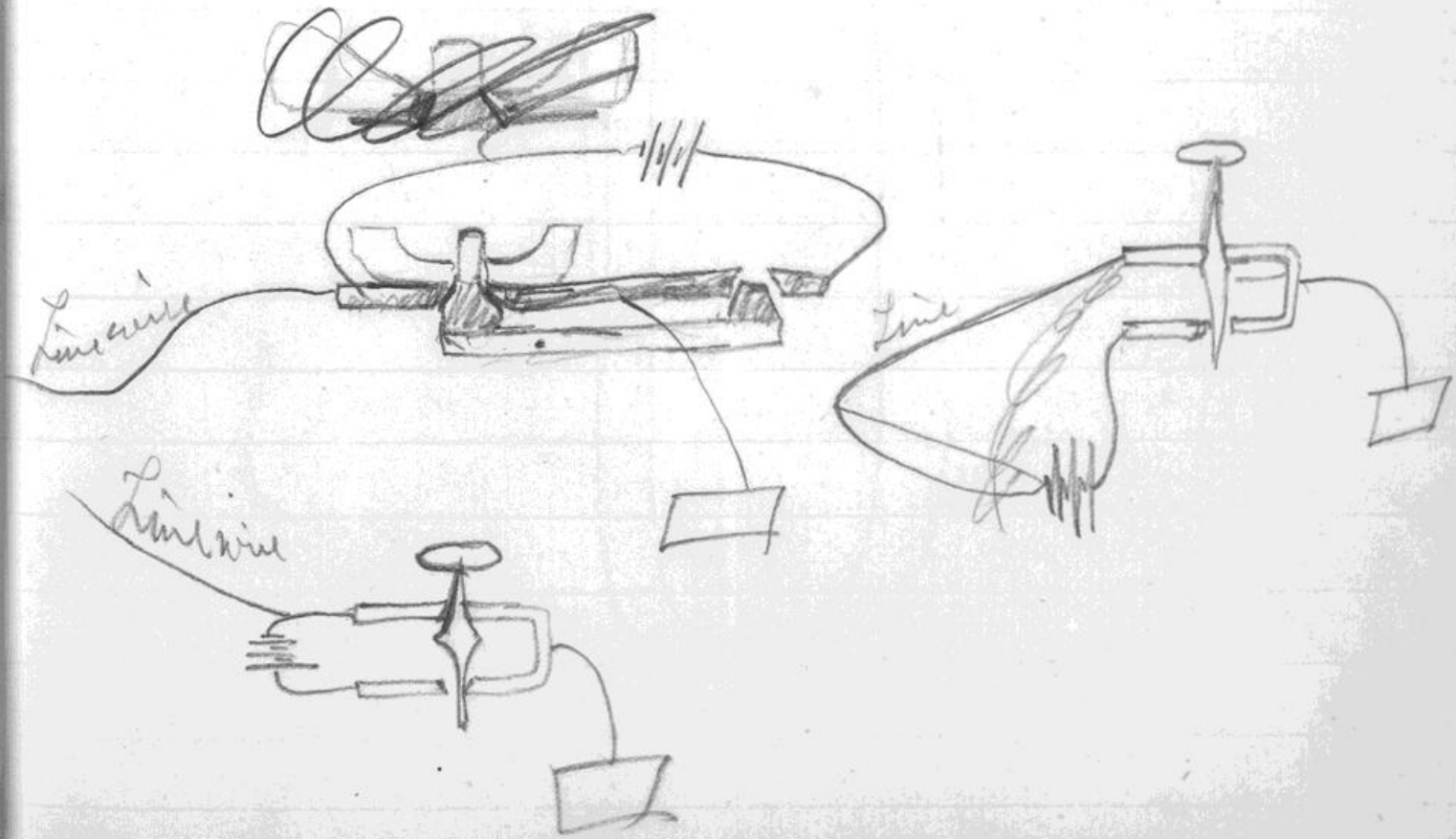
196 March 16th

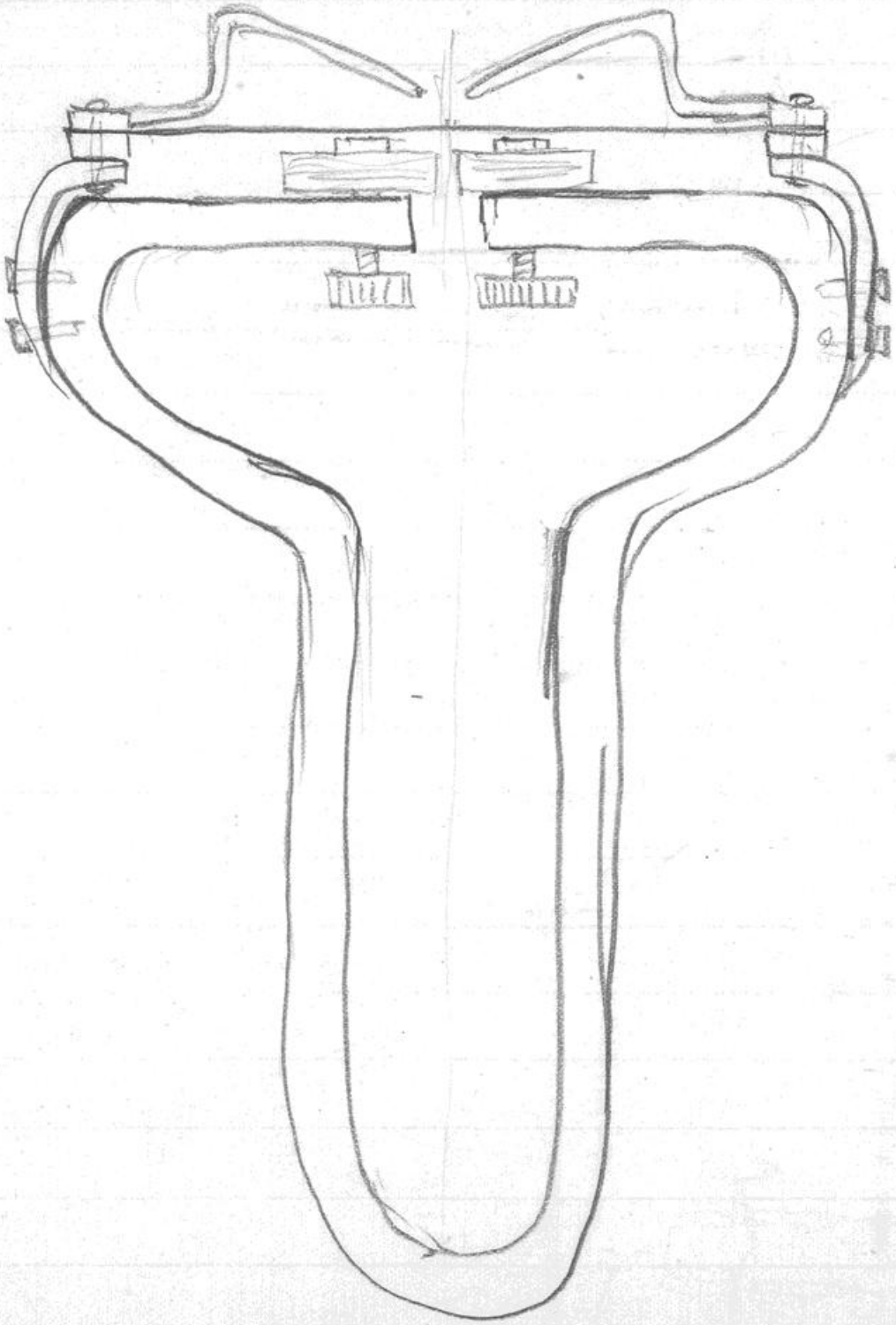




Marche 18^{le}.



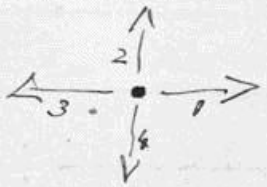




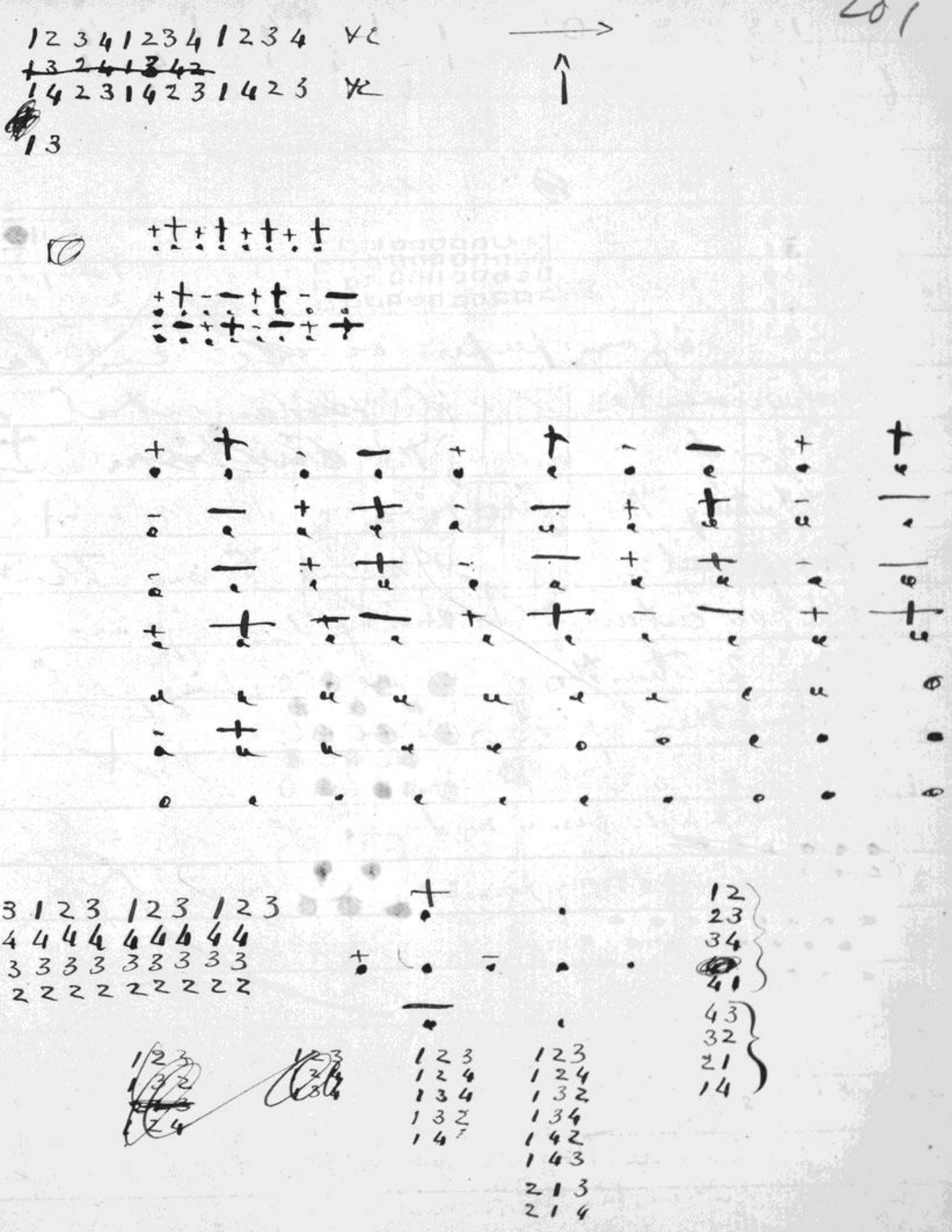
March 21st 1878. Favarger's Autographic plan has suggested thoughts ~~concerning~~ that may be of value in autographic ~~[illegible]~~ telegraphy.

His 3 strengths of currents ~~[illegible]~~ is untenable in practice ~~as testing~~ however feasible it may be upon paper or ~~[illegible]~~ in laboratory experiments. The fundamental idea is good — namely the ~~[illegible]~~ signal dictating the direction of the motion of the pencil. It seems to me that we can certainly be sure of four signals by using 2 strengths of currents (this being practicable) & making them pos. or neg.

1. Pencil point moves in direction one when weak pos. cur. is used.
2. direction for strong pos. cur.
3. weak neg. cur.
4. strong pos. cur.



Either this or succession idea as suggested by Favarger in his sectional wheel.



202

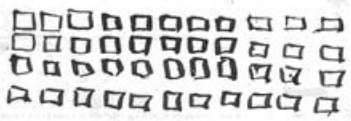
6.
123
124
132
134
142
143

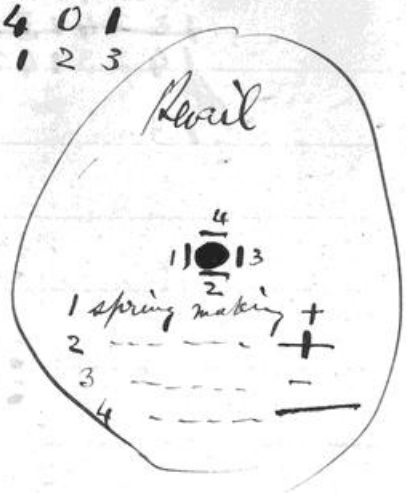
6
213
214
231
234
241
243

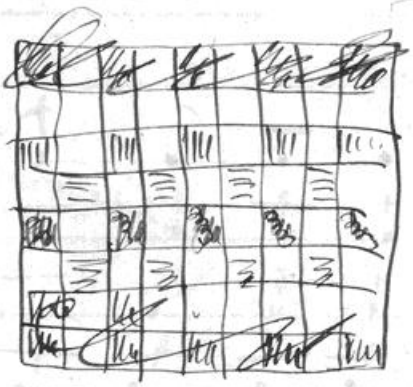
6
312
314
321
324
341
342

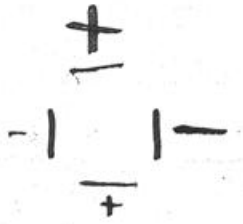
412
413
421
423
431
432

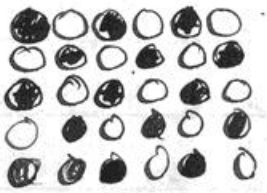
0 1 2 3 4 0 1 2 3 4 0 1 2 3 4
2 3 4 0 1 2 3 4 0 1 2 3 4 0 1
4 0 1 2 3 4 0 1 2 3

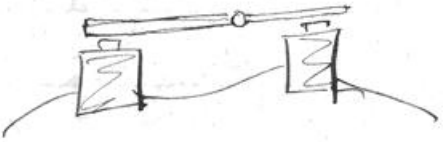


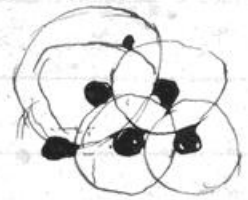






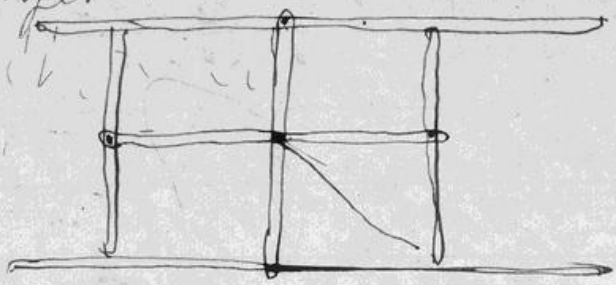


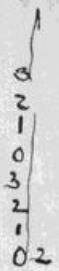




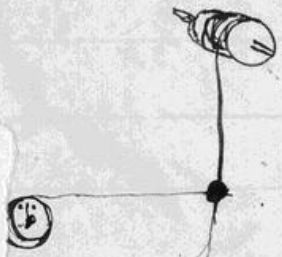
Flower pattern

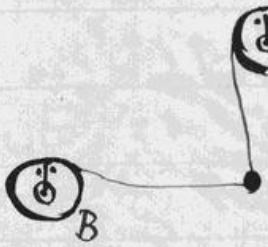
Flower pattern

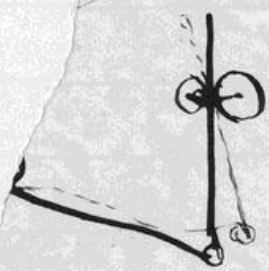


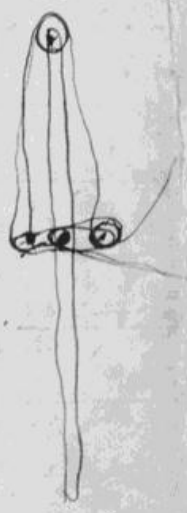


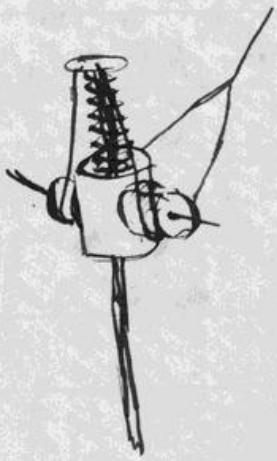
Write with a pencil attached to rollers A B & strings.

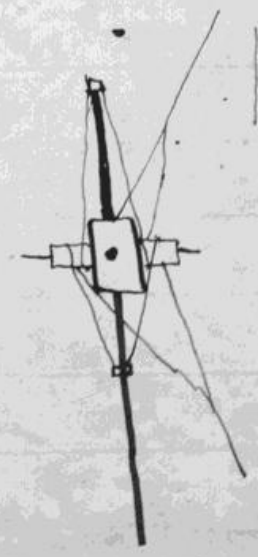












Alexander Graham Bell

1877.